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DEVELOPMENT OF ALUMINUM BASE ALLOYS

SECTION III

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ALCOA RESEARCH LABORATORIES
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ALUMINUM COMPANY OF AMERICA
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July 25, 1966

Commanding Officer Frankford Arsenal
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Philadelphia, Pennsylvania 19137

Attn: Mr. Harold Markus
SMUFA-1320

REF: CONTRACT NO. DA-36-034-ORD-3559RD
DEVELOPMENT OF ALUMINUM BASE ALLOYS

Dear Mr. Markus:

Enclosed is one (1) copy of Section III of the Final Report of the subject contract covering the period September 29, 1961 to September 30, 1965. Section II of the captioned report has already been completed and distributed; Section I is being assembled into rough draft form for your approval.

Copies of Section III are being distributed according to the report's distribution list.

Very truly yours,

J. P. LYLE, JR., Assistant Chief
Physical Metallurgy Division

JPL/mmk

Enclosure

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DEVELOPMENT OF ALUMINUM-BASE ALLOYS-Section III (Unclassified)

FINAL REPORT

FOR THE PERIOD SEPTEMBER 29, 1961 to SEPTEMBER 30, 1965

CONTRACT NO. DA-36-034-ORD-3559RD

MAY 31, 1966

by

A. P. HAARR

ALCOA RESEARCH LABORATORIES
ALUMINUM COMPANY OF AMERICA

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FOREWORD

New highs in the strengths of aluminum alloy products were the object of Contract No. DA-36-034-ORD-3559RD. This contract has been successfully completed. The final report covers all the work done on the contract since its beginning in September 1961, and is divided into three parts:

I. Outline of information on the most promising alloys. The preferred processes and compositions are described.

II. Fabricating Development.

The development of the processes which achieved the desired properties and products is described, and recommendations for further study are made.

III. Alloy Development.

The development of alloy compositions and thermal practices which achieved the desired properties is described, and recommendations for further study are made.

ABSTRACT - SECTION III

The objectives of this alloy development research program were: (1) aluminum alloys with 125,000 psi yield strength, (2) aluminum alloys with yield strengths at least 10% higher than commercial alloys with no sacrifice in resistance to stress corrosion cracking (SCC), and (3) determination of tensile properties at elevated and cryogenic temperatures, impact properties, tear properties, electrical conductivities, hardness, and fatigue strengths. All objectives have been met by APM (Aluminum Powder Metallurgy) extrusions made from prealloyed atomized powders using alloys which combine precipitation and dispersion hardening.

1. A yield strength of 124,000 psi was obtained in Alloy 50 containing Al, 9.8 Zn, 4.0 Mg, 0.8 Cu, 1.1 Mn, 1.0 Fe, 1.3 Ni, 0.01 Cr and 0.01 Ti after solution heat treating for 0.5 hours at 920°F, quenching at 2,000-25,000°F/sec., and aging at 225°F for 96 hours.

2. (a) - Alloy 87 containing Al, 7.6 Zn, 2.5 Mg, 1.1 Cu, 2.2 Fe, 2.3 Ni and 0.2 Cr, solution heat treated 2 hours at 860°F, quenched in cold water after aging for 6 hours at 250°F plus 8 hours at 330°F had a yield strength 11% higher than 7075-T7351 and did not fail in A.I. (alternate immersion) when stressed at 75% of Y.S.

   (b) - Alloy 71 containing Al, 9.2 Zn, 3.6 Mg, 0.6 Cu, 0.75 Co and solution heat treated for 2 hours at 860°F, quenched in cold water and after aging 24 hours at 250°F had a yield strength 14% higher than 7178-T651 and did not fail in A.I. when stressed at 25% of Y.S.

   (c) - Alloy 71 after aging 24 hours at 250°F plus 3 hours at 330°F had strengths equal to 7178-T651 and the threshold stress in A.I. was at least twice as high as 7178-T551.

The strengths of some APM alloys are higher than commercial alloys from -112°F to 350°F. Fatigue strengths of smooth specimens of those APM alloys are higher than commercial 7075-T6 and fatigue strengths of notched specimens are at least as high. Impact and tear properties are low but may be improved by further changes in composition, fabrication and heat treatment.

When heat treated to maximum strengths, dispersion hardeners raise strengths slightly but the elongation of such alloys is so low that the potential usefulness is very limited. When "overaged" to lower strengths, however, dispersion hardeners make a very important contribution to resistance to SCC.

The structures were studied by light and electron microscopy, X-ray diffraction and electron microprobe.

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INTRODUCTION

The powder metallurgy approach to alloy development has several attractive features. Atomization of alloys from the melt permits the use of higher concentrations of alloy elements than is possible in ingot metallurgy where the cooling rate is slow relative to atomizing cooling rates. Thus compositions which result in such coarse constituents in ingots that properties or fabricability are impaired, and which result in ingot cracking, can be made by atomizing. The structure of atomized alloy powders is very similar to that of ingot except that powder structures are several orders of magnitude finer. This can be carried over into the products made from powder with the result that wrought products made from atomized alloys can have a very fine structure. Powder metallurgy makes possible the fabrication of dispersion hardened alloys and also alloys combining dispersion hardening with precipitation hardening.

Before this contract began, it was known that high strength aluminum alloy extrusions could be made from prealloyed atomized powder. The alloys fell into three classes: (1) dispersion hardened alloys which are characterized by a high liquid solubility and a low solid solubility at room and elevated temperatures; (2) precipitation hardened alloys which are characterized by a high liquid solubility, a high solid solubility at high temperatures and a low solid solubility at room and intermediate temperatures; and (3) alloys combining the characteristics of the dispersion hardened and precipitation hardened systems. Examples of the three classes from ARL work are:

Alloy	T.S.
(1) 4.5 Fe, 7.0 Ni	69,000 psi
(2) 6.0 Zn, 2.7 Mg, 1.6 Cu, .2 Cr	94,000 psi
(3) 5.7 Fe, 5.5 Ni, 5.3 Zn, 2.4 Mg, 1.7 Cu, .2 Cr	112,000 psi

Other examples can be cited from the work of S. G. Roberts (Ref. 1, 6, 7 and 8):

(1) 5.0 Mn, 2.0 Zr, 0.5 Ti, 0.5 V	59,000 psi
(2) 9.8 Zn, 3.2 Mg, 1.98 Cu, 0.2 Cr	114,000 psi
(3) 12.4 Zn, 2.5 Mg, 2.2 Cu, 3.3 Fe	122,000 psi

For the purposes of this investigation, Zn, Mg, and Cu are considered to be the elements which contribute the most to precipitation hardening. The dispersion forming elements include Mn, Fe, Ni, Cr, Ti, V, Zr, Co, Mo, and W.

It had been found in ARL investigations that high strength powder metallurgy alloys of the Al-Zn-Mg-Cu-Cr type sometimes had unusually good resistance to SCC (stress corrosion cracking) even in the short transverse direction when the alloys were heat treated and aged to their highest strengths, but the results were erratic. Roberts raised the question of SCC in alloys of this type because of their structure but reported no test results to support this speculation.

Roberts used extrusions which were too small to permit testing for transverse tensile properties. The extrusions used in ARL investigations prior to this contract were large enough to permit the determination of transverse properties, but low quality of the extrusions frequently vitiated the results. After the development of a method for making high quality extrusions, which is described in detail in Section II of this report, it was possible to get reliable results in tensile tests and SCC tests in the transverse direction.

OBJECT OF SECTION III

Develop an aluminum alloy with a yield strength of 125,000 psi.

Develop an aluminum alloy with a yield strength at least 10% higher than commercial alloys without a sacrifice in resistance to stress corrosion cracking.

Determine tensile properties at cryogenic and elevated temperatures, impact properties, tear properties, electrical conductivities, hardness, and fatigue properties.

MATERIALS

1. Powders prepared as described in Section II of this report and having the compositions shown in Table I.
2. Two-inch diameter extrusions prepared as described in Section II - Fig. 6 and having the compositions shown in Table II.
3. 0.100 in. sheet prepared by rolling as described in Section II or machined from 2 inch dia. extrusions.

RESULTS AND DISCUSSION

I. Aluminum Alloys With 125,000 psi Yield Strength

A. Selection of Alloys

Various approaches were used in the alloy selection. Alloys 1-3 were based on earlier work performed at ARL. Mr. S. G.

Roberts reported 0.25 in. dia. extrusions made from atomized powders of the same composition as Alloys 4-6 had very high strengths (Ref. 1). Compositions 7-18 contained two levels of Zn, 8% and 12%, and a fixed level of Mg and Cu to which various amounts of dispersion hardening elements were added. The base levels of Zn, Mg and Cu in these alloys were chosen from results of prior work at ARL.

Quaternary Alloys 19-31 constitute a broad survey of certain phase fields in the Al-Zn-Mg-Cu system (Table III). Some of these alloys are outside the limits of ingot metallurgy. Some of them also served as a base for evaluating the effects of dispersion hardening additions. Many of the earlier alloys lay in the $\alpha + S$ and $\alpha + M$ phase fields at 860°F (Ref. 2). The other phase fields investigated are listed in Table III.

Alloys 32-34 and 36-40 were suggested from observed trends. Alloy 35 was raised to a higher Mn level than Alloy 33, so that the Mn would exceed the solid solubility. Alloys 41 and 42 were selected to evaluate the effects of large amounts of Al-Mg-Cr constituents on tensile properties. Alloys 43-59 were selected on the basis of statistical analysis from data generated on Alloys 1-39. A discussion of this and other statistical analyses is found in Appendix A.

It was expected that the effect of omitting dispersion hardeners could be determined by comparing Alloys 60 and 61 with 39 and 50 (or 52) respectively. Alloy 60 is similar to Alloy 39 with a lower Mn level, 1.7% versus 0.77; Alloy 61 is similar to Alloys 50 and 52 without any dispersion hardeners present. However, the comparison was confused by unintentional variations in Zn and Mg.

Alloys 62-74 are modifications of Alloy 32. Alloys 75-84 are modifications of 7178. Alloys 85-87 and 90 are modifications of Alloy 34. Alloys 88 and 89 are the same compositions as 79 and 87 respectively, but the former are mixtures of powders instead of prealloyed powders.

B. Properties of Extrusions

1. Tensile Properties

Table II summarizes the properties of the extrusions. Attention is called to the ultrasonic rating; over 75% of the sections examined exceeded SNT Class A with 95% meeting or exceeding Class A.

The densities of the extrusions, Table II, are probably essentially 100% of theoretical, based on the absence of porosity seen in metallographic examinations. The values in Table II were derived from the measured densities of the powders in Table I by multiplying the density of the powder by 1.014 after it was determined that the density of the extrusion was 1.1 to 1.7% higher than that of powder (Table IV). This difference between extrusions and powders is due to sealed pores in the atomized powder particles which are not filled by the liquid in the determination of density by the pycnometer method. This difference in density could also be due in part to techniques used to measure density of powder and extrusion and also to structural changes in fabrication and heat treatment. In Table IV it is seen that the density of the heat-treated and aged extrusions is about 0.3% less than that of the as-extruded material. This is typical of Al-Zn-Mg-Cu alloys produced in conventional ways (Ref. 3) and gives further evidence of the soundness and low gas content of the extrusions made from powder by the process described in Section II.

The tensile properties of the alloys are compared in Table II in one or two heat treated conditions: (1) solution heat treated in 2 in. dia. sections for 2 hours at 860°F, quenched in cold water, aged for 24 hours at 250°F or (2) solution heat treated in 1 in. x 1 in. quadrants for 0.5 hours at 920°F, quenched in cold water, aged for 96 hours at 225°F. In general, the second heat treatment resulted in higher strengths. The highest yield strength for Heat Treatment #1 is 112 ksi for Alloy 38; the highest yield strength for Heat Treatment #2 is 117 ksi for Alloys 38 and 70. Incidentally, Alloys 73, 74, 76-78, 80, 81, 84, 88 and 89 were not tested after it became desirable to use available funds in other parts of the program.

The longitudinal tensile properties are generally uniform between the front and back of the extrusions; the greatest difference for Heat Treatment #1 is 5,200 psi. Transverse yield strengths were usually not determined since failure occurred before a 0.2% offset was reached. The strain followers were damaged in some cases due to premature failures, therefore only the tensile strengths were usually measured. The transverse tensile strength is much lower than the longitudinal value and greater variations exist between the front and back. The greatest differences are 63,200 psi for Alloy 66 and 39,100 psi for Alloy 9; these large differences are probably a result of internal defects. The higher property is probably more representative of the potential of the alloy.

The heat treatments reported in Table II do not necessarily develop the highest properties in these alloys. Examples of increases which can be obtained are shown in Table V where it is seen that combinations of higher solution heat treat temperature, longer aging times, and lower aging temperatures tend to raise tensile strengths; the effectiveness of these treatments depends on alloy composition. Higher solution heat-treat temperatures, however, tend to increase cracking and splitting during quenching. The tensile strength of Alloy 39 was raised to 122 ksi by a solution heat treatment of 2 hours at 920°F followed by aging for 96 hours at 225°F. The time at solution heat treatment temperatures may also affect properties slightly as shown in Table VI, which suggests that highest strengths are obtained with shortest times.

Tensile and yield strengths increase with increasing quench rates as shown in Table VII, Figure 1, and Figure 2. The quench rates are only rough estimates, but the trend is at least qualitatively reliable. The high strength objective of this contract was substantially achieved by Alloy 50 having a tensile strength of 127,500 psi and a yield strength of 124,000 psi when solution heat treated for 0.5 hours at 920°F, quenched at 2,000-25,000°F/sec., and aged for 96 hours at 225°F. The highest Y.S.: density (1.17×10^6 in.) was found in Alloy 52 when solution heat treated for 0.5 hours at 920°F, quenched at approximately 25,000°F/sec., and aged for 96 hours at 225°F.

The compact preheat temperature can have an effect on quench sensitivity as shown in Figure 2 for Alloy 50. A 900°F preheat results in a higher quench sensitivity than a 1000°F preheat. The same trend was observed in Alloy 52.

2. Tensile Properties at Cryogenic and Elevated Temperatures

The ten alloys evaluated at cryogenic and/or elevated temperatures are listed in Table VIII. Only four alloys were tested below room temperature. Properties of 7075-T6 and X2020-T6 extrusions fabricated from ingot are included also for purposes of comparison. The effect of the temperature on tensile strengths is best illustrated in Figure 3. (Alloy 52 is the only APM alloy shown since the other alloys responded in a similar fashion.) The APM alloy has a definite strength advantage up to about 375°F, above which X2020-T6 takes over.

The effect of time at temperature on the tensile properties of Alloy 52 was also investigated; the results are given in Table IX and Figure 4 and 5. Again the APM alloy has the highest strength up to about 375°F at which time X2020-T6 surpasses it. The lack of data for Alloy 52 between 212°F and 400°F leaves some question as to whether this alloy has a curve as illustrated in Figure 3 or one more similar to that of 7075-T6.

3. Notch Toughness and Tear Resistance

The notch toughness and/or tear resistance of Alloys 38, 52, 62, 64 and 71 were determined. The former property was evaluated by use of the Izod impact test on heat treated 2 in. dia. extruded rod machined into test specimens as specified by ASTM Standard E-23-60T. The tear resistance was evaluated by means of a Kahn-Type tear test on 0.10 in. thick sheet. This sheet was produced by either rolling of 1 in. x 4-1/4 in. extruded slab or machining a "sheet type" specimen from a 2 in. dia. extrusion. This test measures the energy necessary to initiate a crack in the specimen and the energy necessary to propagate this crack to complete failure and is described in Ref. 4.

The Izod impact tests revealed the brittleness of the APM alloys and the impact resistance is closer to that of casting alloys than to extruded material, Table X. The sheet rolled from extrusions was very notch sensitive, the energy required to initiate a crack ranging from 1.2 to 2.4 in.-lb. Once the crack was initiated, it propagated without additional energy being needed until complete failure occurs. This is much lower than the values usually obtained from sheet, and is even lower than values obtained for castings.

The tear resistance of certain step aged 0.10 in. thick sheet machined from 2 in. dia. extrusions compared favorably with commercial alloys, Table XI. The tear strength to yield strength ratios are generally lower than the commercial alloys because of the higher yield strengths obtained for the APM alloys. Alloy 71 looks promising when compared with 7178-T6.

4. Electrical Conductivity

Heat treated slices of 2 in. dia. rod and rolled 1 in. x 4-1/4 in. extrusions were measured using the Magnatest type FM-100 Conductivity meter (Table XII). Conductivities follow patterns generally expected from compositions and thermal practices.

5. Hardness

Hardness tests, both Brinell and Rockwell, were made on APM products to determine the values and to try to correlate a possible relationship between hardness and tensile strength. The hardness values were higher than those usually obtained for aluminum but the test results were not reproducible. The data are summarized in Appendix B.

6. Fatigue Tests

The fatigue endurance limits of certain alloys were investigated using a rotating beam specimen in both smooth and notched configurations. The results are discussed in Appendix C.

C. Effectiveness of Dispersion Hardening

One of the original objectives of this investigation was to determine the feasibility of obtaining high tensile strengths by combining dispersion hardening with precipitation hardening. That this approach is effective, at least to a limited extent, is seen from the fact that the highest yield strength obtained in the entire investigation was in an alloy containing significant amounts of Mn, Fe, and Ni in addition to Zn, Mg, and Cu. Furthermore, the highest Y.S. to density ratio was obtained in an alloy containing a large amount of Co in addition to Zn, Mg, and Cu.

It is well, however, to make a judgment as to the effectiveness of the combination of dispersion hardening and precipitation hardening by comparing that kind of alloy with precipitation hardened alloys using the results in Table II. The properties for Heat Treatment #1 in Table II have been arranged in groups according to Zn, Mg, and Cu content in Table XIII. It is seen that dispersion hardeners generally tend to raise tensile and yield strengths (at least up to a point) and to lower elongations.

It is also fairly clear that there is a maximum in the yield strength-amount of dispersoid relationship with that maximum depending on the Zn, Mg, and Cu content as well as on the specific dispersoids present. In all cases, however, the alloys containing dispersoids have such low elongations when heat treated to high strengths that the usefulness of the alloys will be very limited.

Another means of comparing the two types of alloys is on the basis of elongation at a given yield strength-to-density ratio. This is done in Table XIV in which it appears that the two types of alloys are about the same at Y.S.:density greater than 0.95×10^6 and that the precipitation alloys tend to be more ductile at Y.S.:density values of 0.95 and lower.

An attempt was made to assess the effects of dispersion hardening elements on tensile properties by various computer analyses of results obtained in this investigation. While these were not very successful in predicting results, they are included in Appendix A for the record. The highest predicted yield strength for any powder metallurgy extrusion was 127,000 psi for Heat Treatment #1. It is interesting to compare this with a predicted maximum of 122,000 psi for 3/4 in. dia. extrusions made from ingot in another investigation. Allowing for the effect of difference in quench rate between 3/4 in. and 2 in. dia. rod, these analyses would indicate an advantage of 8-10 ksi for the powder metallurgy product. However, the very low elongations of all of the aluminum alloy materials in this strength range make these differences academic; in practice these high strengths are not obtained consistently, possibly due to the difficulties associated with making tensile tests on extremely brittle materials.

The effectiveness of dispersion hardening in alloys which also contain precipitation hardening elements can be judged to some extent from the response of the alloy to factors affecting dispersion hardening. The strength of dispersion hardened alloys based solely on intermetallic compounds having low solid solubility at elevated temperatures, e.g., $FeAl_3$, $FeAl_6$, $FeNiAl_9$, Co_2Al_9, $MnAl_6$, etc., is a function of the volume percent of the dispersed phase and an inverse function of the spacing between the particles of that phase. The interparticle spacing for a given volume percent can be minimized by keeping the times and temperatures at a minimum during preheating, fabrication and heat treatment, and by using finer atomized powders.

The effects of shorter preheat times and lower preheat temperatures were generally opposite to those expected as shown in Table XV. Die quenching, which minimizes times at elevated temperatures by eliminating a separate heat treating operation, also gave unexpected results as shown in Table XVI.

Finer powders gave higher longitudinal strengths than the normal powder in the case of Al-Zn-Mg-Cu alloys given Heat Treatment #2 in Table XVII, but the reverse was true for Al-Zn-Mg alloy and for both types of alloys for Heat Treatment #1. Finer powders (Table XVIII) may give higher transverse strengths than normal powders, but the wide scatter in data shown in Section II - Table VIII requires that this conclusion be treated with reservations.

D. Summary

Higher tensile strengths than ever reported before for Al alloys have been achieved by combining dispersion hardening and precipitation hardening. These high strengths may not be obtainable with precipitation hardening alone. The extremely low ductility, low impact strength and low tear strength associated with these high tensile strengths and the specialized processes required to achieve them will seriously limit the usefulness of these alloys. Practical considerations probably would favor extrusions made from ingot over extrusions made from powder.

II. Development of Aluminum Alloys With Yield Strength 10% Higher Than Commercial Alloys Without Sacrificing Resistance to Stress Corrosion Cracking

When it became apparent that alloys having yield strengths of 125,000 psi would have very low elongations, the emphasis of the investigation was changed. At the suggestion of Mr. Harold Markus of Frankford Arsenal, it was agreed to try to develop alloys and practices to make extrusions which had 10% higher yield strengths than currently available commercial extrusions, elongations of at least 5%, and resistance to SCC (stress corrosion cracking) at least equal to commercial alloys. This amounted to two targets depending on strength and degree of resistance to stress corrosion cracking, based on 7075-T7351 (the strongest commercial alloy with immunity to stress corrosion cracking) and on 7178-T651.

Typical Tensile Properties
(of Extrusions, 2-3" Diameter)

	Longitudinal			Transverse		
Alloy	T.S. ksi	Y.S. ksi	El. % in 4D	T.S. ksi	Y.S. ksi	El. % in 4D
7075-T7351	75	66	11	62	56	4
7178-T651	92	84	8	83	74	5

Targets	Longitudinal Tensile Properties T.S. ksi	Y.S. ksi	El. % in 4D	SCC* ksi
1	83	73	5	>44
2	101	92	5	7

* Highest sustained tension stress in short transverse direction at which test specimen does not fail in the 3.5% NaCl alternate immersion test.

The attack on the targets was to be two pronged: (1) longer aging times and higher aging temperatures than were used to develop the highest tensile strengths, (2) alloys with lower amounts of dispersoids.

In the initial tests (Tables XIX and XX), it was found that these alloys responded to extended aging with much higher increases in elongation than were expected.

Systematic aging studies were made on a number of alloys using 2" diameter extrusions. An extensive effort was made to use Rockwell G hardness measurements to follow the aging, but it was found that the relation between hardness and strength was not very clear and that hardness values could not be interpolated accurately from existing hardness-aging time curves. (The hardness values are tabulated in Appendix B for the record.) Tensile property-aging time relationships for Alloys 2, 3, 4, 5, 6, 19, 20, 28, 33, 36, 38, 39, 49, 50, 52, 59, 60, 61, and 71 are tabulated in Tables XXI through XXXIX. Some of the data are plotted in Figures 6 through 11. The results of stress corrosion tests are given in Tables XXI through XLIII and Figures 12 through 34.

A summary of stress-corrosion cracking results is given in Table XLIV in which the alloys and thermal practices are listed in order of decreasing stress levels.

The following alloys and aging treatments meet the strength and stress corrosion targets.

Alloy	Aging	T.S. ksi	Longitudinal Y.S. ksi	Longitudinal El. % in 4D	SCC Stress ksi	Days to Failure
Target I: 7075-T7351 + 10% With No Failures at 75% Y.S.						
		83	73	5	>48	OK 84
87	6 @ 250 + 8 @ 330	90	81	7	57	OK 84
87	16 @ 330	86	75	7	52	OK 84
79	6 @ 250 + 8 @ 330	86	79	8	54	OK 84
90	6 @ 250 + 8 @ 330	84	78	8	54	OK 84
Target II: 7178-T651 + 10% Strength Improvement, Equal Stress, Corrosion, Resistance						
		101	92	5	7-20	OK 84
71	24 @ 250	108	105	5	22	OK 84
Target III: Better Stress Corrosion Resistance Than 7178-T651						
		92	84	5	7-20	OK 84
71	24 @ 250	108	105	5	22	OK 84
90	24 @ 250	99	93	5	20	OK 28
71	24 @ 250 + 3 @ 330	94	88	7	40	OK 84

(The alloys were all SHT 2 hours at 860°F and immediately quenched in cold water prior to aging.) Target III was not included as one of the original two targets but was considered. A more complete summary is given in Table XLV which lists the composition of these alloys as well as alloys which may meet the targets with adjustments in aging practices.

The susceptibility of APM alloys to exfoliation was evaluated on 1 in. x 4-1/4 in. extruded sections of Alloy 52, S.No. 293690 using an improved accelerated test of acetic acid-sodium chloride intermittent spray at 95°F for a 2 week exposure (Ref. 5). The extrusions were sawed such that surface and mid-plane surfaces would be exposed in the as-extruded (-W) temper, given Heat Treatment #1 (SHT 2 hours at 860°F, C.W.Q., Aged 24 hours at 250°F) and given Heat Treatment #1 with an additional step aging of 4 hours at 330°F. All heat treatments were conducted prior to the sample preparation. Generally, the mid-plane and surface of the specimens were covered with small shallow pits and a mild form of corrosion. There was no indication of exfoliation on any of the panels. Extrusion lines were visible on the panel surface after exposure. Heat Treatment #1 panels resisted the corrosive environment best. The -W temper pieces exhibited slightly more pitting; the step-aged panels had more pits than the as-extruded panels.

III. Structure

The structures of atomized alloy powders and extrusions made from them are fine relative to ingot and ingot extrusions, and the structures of extrusions are coarser than the powders from which they were made (Figures 35-37).

In the early stages of this investigation, large constituent particles which were present in some of the extrusions were analyzed by electron microprobe with the results shown in Table XLVI. It was concluded from the analyses that Fe, Ni, Co, and Mn were desirable elements for dispersion hardening because they tended to be absent from (or present in relatively slight amounts in) the large constituent particles.

Guinier X-ray diffraction also revealed that the Zn, Mg, Cu, and Mn, were present in the same phases in powder metallurgy extrusions (Table XLVII) that occur in products made from ingot.

After it became apparent that Alloys 34, 87, 52, and 71 had good strengths combined with good resistance to SCC, a somewhat more extensive study was made of the structure.

Extrusions of these alloys all had essentially the same structures when viewed by the light microscope, and Figure 38 showing Alloy 71 in the -T6 condition serves as an example. The two-step aged condition, Figure 39, shows no obvious difference in structure, but may contain a little more precipitate.

The electron microprobe was used to analyze 14 to 15 of the larger particles in extrusions of Alloys 34, 87, 52 and 71, as illustrated by the black phases in Figure 38, Tables XLVIII and XLIX. It was determined that some of the particles were non metallic, i.e., their composition could not be entirely accounted for in the microprobe analysis. It should be noted that the percentage figures reported for the non-metallic particles cannot be considered to be quantitatively correct because of uncompensated absorption effects and are given only to indicate order of magnitude. The percentage figures for the metallic particles are somewhat more meaningful because approximate absorption corrections were made; quantitative accuracy is still questionable. Sixty percent of the larger particles in Alloy 34 were approximately 40% Zr and 10% Si (probably $ZrSiO_4$) while 29% of the particles in Alloy 87 had a similar composition. No Zr was reported in the semiquantitative chemical analysis. These particles are probably part of the Zirconite paste wash which was applied to the crucible prior to melting a charge. The particles flaked off or were chipped off during stirring to become part of the atomized product. The higher $ZrSiO_4$ concentration occurred in the larger charges. The presence of Cr, Fe, Si, and Ni in certain of the large constituent particles indicate more work should be done to minimize growth of these particles. Mn and Co do not occur as large constituent particles and are desirable. The effect of Zn and Mg varies; sufficient data are not available to come to any conclusions at this time.

Alloys 34, 87, 52, and 71 were also analyzed by the Guinier X-ray diffraction technique. Not only were attempts made to identify the phases present but also to determine the formation of additional phases when progressing from the powder to -T6 extrusion and finally after prolonged aging. Only 2 or 3 phases were indicated as being present in the powder, Table L, Al, Mg_2Si and either $FeNiAl_9$ or Co_2Al_9, depending on the alloy. After the powder is compacted, extruded and given a -T6 heat treatment, the structure becomes quite complex. Additional phases appear including one or more phases which cannot be identified. Prolonged aging results in an apparent increase in the amount of $FeNiAl_9$ but no change in the amount of $CoAl_9$. Prolonged aging also results in the appearance of an M' precipitate. Other phases stay relatively unchanged.

Examination of the powders by electron microscope indicates the microstructures of Alloys 34 and 87 are somewhat coarser than that of Alloys 52 and 71, Figures 40 to 43. Alloy 71, Figure 43, appeared to have a less uniform structure in terms of constituent dispersion than the other powders.

The microstructures of Alloys 34 and 87 extrusions are quite similar, Figures 44, 45, 46, and 47. Prolonged aging of both these alloys results in an increase in the large dark particles labeled $MgZn_2$. The gray particles are believed to be $FeNiAl_9$ and the number does not change appreciably. The smaller, more spherical particles are probably the E-phase ($Al_{12}MgCr$) dispersoid. The Mg_2Si precipitate would be present in small quantity and is not easily identified. A very fine, light background precipitate also appears to increase during step aging. This is similar to the θ' phase which occurs in alloys containing Cu, but a positive identification was not made. This could also be the M' or unidentified phase noted in X-ray diffraction.

Alloys 52 and 71 are also similar in composition, but the amount of precipitate present in Alloy 52 is greater than for any of the other alloys, Figures 48, 49, 50 and 51. The differences between the $MgZn_2$ and the $Mg_3Zn_3Al_2$ phases are indistinguishable in the electron micrographs. The Co_2Al_9 dispersoid is believed to be the light gray angular particles. Alloy 71 exhibits noticeable grain (or subgrain) boundary precipitation, especially after step aging. Note the increase in precipitate around the Co_2Al_9 particles.

Small phases within the larger phases are noted in Figures 44 to 51. The compositions of the larger phases could be influenced by these smaller included phases when analyzed by the microprobe.

The microprobe has also been used to investigate tensile specimen fractures of two specimens of Alloy 59 in which low strengths and low elongations had been observed. The origin of failure appeared to be a region containing black inclusions. Test results indicate the black spot inclusions have a high Mg content, a moderate amount of Al and low-to-trace amounts of Zn, Mn, Ni, Fe and Cu. The level of each of these elements, with the exception of Mg, is far less in the dark region than in the surrounding region of the fracture. A thin layer of Mg-rich material, a spinel or possibly MgO, is present in the "black spot" regions. Thus low strengths and elongations can be the result of greater than normal oxidation.

CONCLUSIONS

1. The longitudinal tensile properties of certain APM alloys exceeded 100 ksi and were uniform along the length of the extrusion. The transverse tensile properties were lower than the longitudinal and failure frequently occurred before the yield strength at 0.2% offset was reached.

2. The ductility of the alloys generally decreased as the strength increased.

3. Alloy 50, Al, 9.8% Zn, 4.0% Mg, 0.8% Cu, 1.1% Mn, 1.0% Fe, 1.3% Ni, 0.01% Cr and 0.01% Ti, had the highest strength values with a yield strength of 124,400 psi and a tensile strength of 127,500 psi.

4. Alloy 52 containing 10.0% Zn, 4.0% Mn, 0.9% Cu, 0.4% Mn, 0.02% Ti, 0.01% Cr and 1.5% Co had the highest yield strength to density ratio, 1.174×10^6 in.

5. The extrusion densities are higher than the powder densities due to the inability of the testing fluid to completely fill all voids and crevices.

6. The difference in the densities of the extrusions tested in the -F and -T6 conditions is similar to that of conventional wrought alloys.

7. Compact density and compact preheat temperature affect the tensile properties of a fabricated product from a given alloy.

8. The tensile strengths of an alloy increase with the quench rate. Quench rates are determined by the specimen size and the quenching medium.

9. Alloy composition affects the quench sensitivity of alloys.

10. Compact preheats of 1000°F result in extrusions with less quench sensitivity than 900°F preheats.

11. Elevated and cryogenic tensile tests on selected alloys indicate the properties are superior to conventional alloys up to 350°F. Above this temperature the tensile strength decreases rapidly.

12. Increasing the time at elevated temperatures from 1/2 to 100 hours results in a lowering of strengths and an improvement on the ductility. Comparison with other alloys for similar time at temperatures indicates that Alloy 52 again has superior properties up to about 350°F.

13. The tear strength values, while lower than some commercial alloys, can be improved by prolonged aging of the more ductile alloys.

14. The poor notch sensitivity of these extrusions is indicated by the low Izod impact test values.

15. The conductivity of these alloys varies depending on composition and aging practice.

16. The alloys are generally harder than commercial APM alloys.

17. Attempts to correlate hardness or conductivity data and tensile properties have not been successful.

18. The fatigue endurance limit on smooth specimens of Alloys 52, 62, 64, and 71 are greater than 7075-T6 and the data points generally fall above the upper scatter band limit for 7075-T6.

19. Dispersion hardeners generally tend to raise the tensile and yield strengths and lower the elongation.

20. The alloys respond to prolonged aging by increased ductility and resistance to stress corrosion cracking. The strengths decrease.

21. Alloy 71 responds very well to overaging. The strengths are almost as high as those obtained for Alloy 52, however, the material is much more ductile.

22. Alternate immersion stress corrosion tests have a varied response on the short transverse specimens from extrusions. Alloy content and heat treatments determine the effect.

23. Stress corrosion resistance of alloys given prolonged aging and containing high Fe and Ni (Alloys 34, 87 and 90) resulted in no failures at stress levels significantly greater than typical values of 7075-T73. Heat Treatment #1 resulted in very high strengths with better stress corrosion resistance than 7075-T6 or 7178-T6.

24. Alloys 52 and 71, Co containing series, had stress corrosion resistance better than that obtained for 7075-T73 + 10% after prolonged aging. Although not as good as the Fe-Ni series, the ductility of these alloys is greater.

25. No indication of exfoliation corrosion was present in Alloy 52. The general effect of exfoliation corrosion on APM material is not known.

26. The maximum dispersion strengthening effect was not achieved from the insoluble elements because the constituent particles in the extrusions were coarsened considerably over those in the atomized powder.

27. The electron microprobe indicated that the coarse constituents contained large amounts of Cr, Ti, V, Zr, Mo and W. These alloying elements are therefore considered undesirable in large amounts.

28. Fe, Ni, Co and Mn are desirable elements for dispersion hardeners since they are not present as large constituent particles.

FUTURE WORK

A total of 90 alloys have been partially evaluated. The results have indicated that at least two families of alloys should be given additional testing, namely, Al-Zn-Mg-Co-Cu (Alloys 52 and 71) and Al-Zn-Mg-Cu-Fe-Ni (Alloys 34, 87 and 90). Additional testing has shown that these alloys are indeed promising but many unanswered questions are still present, i.e., alloy limits, purity, fabrication techniques, more complete stress corrosion data in both alternate immersion and atmospheric tests, etc. Also, means of improving some of the poor properties, i.e., ductility and tear strength, must be made. Both alloy systems should be included as part of an extensive program to obtain a high strength commercial alloy.

The alloys obtained by use of statistical analyses should be produced and fabricated to determine how accurate the model was and also to improve the model.

Other families of alloys could be included for further evaluation, however, the emphasis should be directed toward the alloys discussed in the earlier paragraphs.

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TABLE I

COMPOSITION AND PROPERTIES OF POWDERS

Alloy No.	Series	S.No.	Material Analyzed	Zn	Mg	Cu	Mn	Fe	Ni	Cr	Ti	V	Zr	Co	Mo	W	Si	Al_2O_3 (a)	Powder Density, lb./in.^{3} (b)	Powder Size MMD, microns
				Composition, %																
1		—	Intended	9.86	3.49	1.02	0.47	—	—	—	—	—	—	—	—	—	—	—	—	—
1	A	267958	Powder	10.0	3.53	1.04	0.50	0.12	—	0.00	0.00	—	—	—	—	—	0.06	0.5	.1014	44
1	A	277373	Extrusion	9.94	3.53	1.07	0.52	0.08	—	0.01	0.00	—	—	—	—	—	0.05	0.3	----	—
2		—	Intended	12.0	3.50	1.50	0.50	—	—	—	—	—	—	—	—	—	—	—	—	—
2	A	267869	Powder	12.1	3.48	1.51	0.54	0.13	—	0.00	0.01	—	—	—	—	—	0.08	0.4	.1038	54
3		—	Intended	12.30	4.05	1.53	0.50	—	—	—	—	—	—	—	—	—	—	—	—	—
3	A	267870	Powder	12.3	4.03	1.56	0.53	0.13	—	0.00	0.01	—	—	—	—	—	0.08	0.5	.1038	27
4		—	Intended	9.76	3.24	1.99	—	—	—	0.20	—	—	—	—	—	—	—	—	—	—
4	A	267871	Powder	9.60	3.19	1.99	0.00	0.16	—	0.23	0.01	—	—	—	—	—	0.05	0.4	.1027	39
5		—	Intended	10.36	3.08	2.03	1.74	—	—	0.20	—	—	—	—	—	—	—	—	—	—
5	A	267872	Powder	10.3	2.93	2.07	1.80	0.21	—	0.14	0.00	—	—	—	—	—	0.11	0.6	.1047	37
6		—	Intended	11.25	2.45	2.01	—	—	—	0.20	—	—	—	—	—	—	—	—	—	—
6	A	267873	Powder	11.2	2.44	2.03	0.01	0.16	—	0.17	0.01	—	—	—	—	—	0.06	0.4	.1045	39
7		—	Intended	8.0	3.5	1.5	—	2.5	2.5	—	—	—	—	—	—	—	—	—	—	—
7	A	267960	Powder	7.92	3.41	1.52	0.01	2.50	2.00	—	—	—	—	—	—	—	0.02	0.2	.1043	26
8		—	Intended	8.0	3.5	1.5	1.5	1.5	1.5	—	—	—	—	—	—	—	—	—	—	—
8	A	267961	Powder	7.88	3.46	1.50	1.58	1.63	1.40	—	—	—	—	—	—	—	0.06	0.4	.1042	44
9		—	Intended	8.0	3.5	1.5	—	—	—	0.5	0.5	0.5	0.5	—	—	—	—	—	—	—
9	A	267962	Powder	7.88	3.54	1.60	0.01	0.13	—	0.48	0.38	0.41	0.44	—	—	—	0.07	0.5	.1023	38
10		—	Intended	8.0	3.5	1.5	—	—	—	2.0	0.8	2.0	1.0	—	—	—	—	—	—	—
10	A	267963	Powder	7.91	3.54	1.51	0.04	0.15	—	2.13	0.89	1.73	0.85	—	—	—	0.08	0.5	.1050	39
11		—	Intended	8.0	3.5	1.5	—	—	—	—	—	—	—	1.5	1.5	1.5	—	—	—	—
11	A	267964	Powder	8.03	3.54	1.53	0.01	0.10	—	—	—	—	—	1.48	1.19	0.39	0.10	0.4	.1033	37
11	A	277383	Extrusion	7.55	3.54	1.52	0.01	0.09	—	—	—	—	—	1.37	1.55	0.48	0.08	0.2	----	—
12		—	Intended	8.0	3.5	1.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	—	—	—	—
12	A	267965	Powder	7.81	3.53	1.56	0.61	0.51	0.55	0.53	0.44	0.39	0.56	0.50	0.50	0.46	0.09	0.4	.1046	41
13		—	Intended	12.0	3.5	1.5	—	2.5	2.5	—	—	—	—	—	—	—	—	—	—	—
13	A	267966	Powder	11.7	3.43	1.52	0.02	2.43	2.23	—	—	—	—	—	—	—	0.05	0.2	.1081	37
14		—	Intended	12.0	3.5	1.5	1.5	1.5	1.5	—	—	—	—	—	—	—	—	—	—	—
14	A	267967	Powder	11.8	3.47	1.52	1.65	1.64	1.45	—	—	—	—	—	—	—	0.07	0.5	.1033	35
15		—	Intended	12.0	3.5	1.5	—	—	—	0.5	0.5	0.5	0.5	—	—	—	—	—	—	—
15	A	267968	Powder	11.4	3.40	1.50	0.02	0.14	—	0.54	0.51	0.46	0.55	—	—	—	0.07	0.3	.1054	33

(Continued)

TABLE I (Cont'd.)

Alloy No.	Series	S. No.	Material Analyzed	Zn	Mg	Cu	Mn	Fe	Ni	Cr	Ti	V	Zr	Co	Mo	W	Si	Al_2O_3 (a)	Powder Density lb./in.^{3} (b)	Powder Size [illegible]D-microns
16		—	Intended	12.0	3.5	1.5	—	—	—	2.0	0.8	2.0	1.0	—	—	—	—	—	—	—
16	A	267969	Powder	12.0	3.54	1.52	0.04	0.13	—	2.18	1.06	1.89	0.98	—	—	—	0.08	[illegible]	.1089	[illegible]
17		—	Intended	12.0	3.5	1.5	—	—	—	—	—	—	—	1.5	1.5	1.5	—	—	—	—
17	A	267970	Powder	11.9	3.46	1.55	0.00	0.10	—	—	—	—	—	1.48	1.10	0.54	0.08	[illegible]	.1067	41
18		—	Intended	12.0	3.5	1.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	—	—	—	—
18	A	267971	Powder	11.7	3.38	1.52	0.62	0.54	0.56	0.54	0.45	0.39	0.54	0.50	0.50	0.50	0.11	[illegible]	.1050	39
19		—	Intended	7.6	3.0	1.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	A	267972	Powder	7.49	2.97	1.70	0.00	0.17	—	0.00	0.00	—	—	—	—	—	0.06	[illegible]	.1004	42
20		—	Intended	7.9	3.6	2.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	A	267973	Powder	7.7[illegible]	3.59	2.33	0.00	0.17	—	0.00	0.00	—	—	—	—	—	0.06	[illegible]	.1007	[illegible]3
21		—	Intended	8.0	5.6	7.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	A	267974	Powder	7.92	5.40	7.[illegible]	0.00	0.1[illegible]	—	0.00	0.00	—	—	—	—	—	0.06	[illegible]	.1039	42
22		—	Intended	8.0	9.5	15.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22	A	267975	Powder	7.93	9.39	14.9	0.00	0.13	—	0.00	0.00	—	—	—	—	—	0.06	[illegible]	.1085	43
23		—	Intended	8.0	10.3	20.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—
23	A	267976	Powder	7.71	10.1	20.1	0.00	0.12	—	0.00	0.00	—	—	—	—	—	0.06	[illegible]	.1130	34
24		—	Intended	8.0	7.5	20.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24	A	267977	Powder	7.76	7.16	20.0	0.00	0.14	—	0.00	0.00	—	—	—	—	—	0.06	[illegible]	.1151	27
25		—	Intended	—	10.8	2.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25	A	267978	Powder	—	10.6	2.37	0.00	0.19	—	0.00	0.00	—	—	—	—	—	0.06	[illegible]	.0927	39
26		—	Intended	3.0	7.5	2.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26	A	267979	Powder	2.95	7.41	2.33	0.00	0.17	—	0.00	0.00	—	—	—	—	—	0.07	[illegible].2	.0944	50
27		—	Intended	7.0	4.0	2.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
27	A	267980	Powder	6.90	3.93	2.33	0.00	0.15	—	0.00	0.00	—	—	—	—	—	0.08	[illegible]	.1000	38
28		—	Intended	10.0	4.0	2.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
28	A	267981	Powder	9.77	3.83	2.28	0.00	0.16	—	0.00	0.00	—	—	—	—	—	0.07	[illegible].3	.1028	34
29		—	Intended	14.0	4.4	2.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
29	A	267982	Powder	13.7	4.33	2.33	0.00	0.12	—	0.00	0.00	—	—	—	—	—	0.07	[illegible].2	.1054	[illegible]2
30		—	Intended	8.0	15.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
30	A	267983	Powder	7.90	14.6	0.02	0.00	0.12	—	0.00	0.00	—	—	—	—	—	0.07	[illegible]	.0928	2[illegible]

(Continued)

TABLE I (Cont'd.)

Alloy No.	Series	S. No.	Material /Analyzed	Composition, % Zn	Mg	Cu	Mn	Fe	Ni	Cr	Ti	V	Zr	Co	Mo	W	Si	Al_2O_3(a)	Powder Density lb./in.^{3} (b)	Powder Size MMD-microns
31[4]		—	Intended	3.0	15.0	2.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
31	A	267984	Powder	2.94	14.6	2.38	0.00	0.13	—	0.00	0.00	—	—	—	—	—	0.09	0.3	.0922	31
32		—	Intended	6.45	2.70	0.61	—	—	1.97	0.10	—	—	—	—	—	—	—	—	—	—
32	A	264173	Powder	6.59	2.71	0.64	0.00	0.10	2.27	0.07	0.01	—	—	—	—	—	0.09	0.3	.1011	44
33		—	Intended	9.15	3.44	1.17	1.10	—	—	—	—	—	—	—	—	—	—	—	—	—
33	A	264174	Powder	8.95	3.47	1.18	1.13	0.15	0.00	0.01	0.01	—	—	—	—	—	0.10	0.3	.1018	41
34		—	Intended	8.0	2.5	1.0	—	3.25	5.0	0.10	—	—	—	—	—	—	—	—	—	—
34	A	264175	Powder	7.79	2.50	1.00	0.02	3.20	4.92	0.19	0.02	—	—	—	—	—	0.08	0.3	.1074	44
34	A	277406	Extrusion	7.78	2.53	1.03	0.04	3.93	5.34	0.19	0.01	—	—	—	—	—	0.08	0.3	----	-
34	C	283269	Powder	7.77	2.48	1.03	0.02	3.49	4.94	0.09	0.01	—	—	—	—	—	0.07	0.59	.1083	24
35		—	Intended	9.15	3.44	1.17	2.5	—	—	—	—	—	—	—	—	—	—	—	—	—
35	A	277365	Powder	9.01	3.41	1.16	[illegible]	0.19	0.00	0.00	0.01	—	—	—	—	—	0.11	0.3	.1024	45
36		—	Intended	11.0	3.7	2.0	1.7	—	—	—	—	—	—	—	—	—	—	—	—	—
36	A	252974	Powder	10.7	3.82	2.04	1.66	0.13	—	—	—	—	—	—	—	—	0.10	0.8	.1061	35
36	B	277920	Powder	10.6	4.36	1.97	1.68	0.20	0.00	—	—	—	—	—	—	—	0.11	0.2	.1044	22
37		—	Intended	8.5	3.5	—	2.0	4.0	6.0	—	—	—	—	—	—	—	—	—	—	—
37	A	252976	Powder	8.43	3.52	0.02	2.06	3.32	6.03	—	—	—	—	—	—	—	0.12	0.8	.1112	43
38		—	Intended	8.5	3.5	—	1.0	1.0	3.0	—	—	—	—	—	—	—	—	—	—	—
38	A	252977	Powder	8.36	3.62	0.02	1.00	0.91	3.10	—	—	—	—	—	—	—	0.09	0.8	.1056	39
38	A	277426	Extrusion	8.39	3.56	0.02	1.02	0.76	2.80	—	—	—	—	—	—	—	0.08	0.2	----	—
38	B	277729	Powder	8.15	3.33	0.00	1.06	1.08	2.96	—	—	—	—	—	—	—	0.10	0.18	.1035	22
38	C	283270	Powder	8.48	3.53	0.01	1.08	1.21	2.95	0.00	0.01	—	—	—	—	—	0.07	0.66	.1045	24
39		—	Intended	11.0	5.0	2.0	1.7	—	—	—	—	—	—	—	—	—	—	—	—	—
39	A	252978	Powder	10.9	4.89	2.04	1.74	0.33	—	—	—	—	—	—	—	—	0.11	0.9	.1053	35
39	C	283271	Powder	10.9	4.90	2.00	1.79	0.19	0.00	0.00	0.00	—	—	—	—	—	0.09	0.63	.1046	24
40		—	Intended	8.5	5.0	—	1.0	1.0	3.0	—	—	—	—	—	—	—	—	—	—	—
40	A	252979	Powder	8.42	5.15	0.02	1.02	0.72	3.00	—	—	—	—	—	—	—	0.09	0.8	.1044	42
41		—	Intended	8.0	5.0	—	—	—	—	3.0	—	—	—	—	—	—	—	—	—	—
41	A	277871	Powder	7.96	4.62	0.01	—	0.15	—	2.94	0.00	—	—	—	—	—	0.16	0.15	.1013	28
42		—	Intended	8.0	4.3	—	—	—	—	2.0	—	—	—	—	—	—	—	—	—	—
42	A	277872	Powder	7.63	3.92	0.05	—	0.18	—	1.96	0.01	—	—	—	—	—	0.09	0.15	.1008	32

(Continued)

TABLE I (Cont'd.)

Alloy No.	Series	S. No.	Material Analyzed	Zn	Mg	Cu	Mn	Fe	Ni	Cr	Ti	V	Zr	Co	Mo	W	Si	Al_2O_3 (a)	Powder Density lb./in.^{3} (b)	Powder Size MMD-microns
				Composition, %																
43		—	Intended	12.0	4.5	1.0	1.0	—	—	0.20	—	—	0.35	—	—	—	—	—	—	—
43	A	278105	Powder	12.0	4.66	0.90	0.86	0.14	0.01	0.20	0.01	—	0.23	—	—	—	0.09	0.28	.1041	18
44		—	Intended	12.0	4.5	1.0	2.4	—	—	0.25	—	—	1.00	—	—	—	—	—	—	—
44	A	276106	Powder	11.2	4.96	0.90	2.53	0.24	0.03	0.23	0.01	—	0.93	—	—	—	0.24	0.33	.1057	20
45		—	Intended	12.0	4.5	1.0	2.8	—	—	0.75	—	—	0.40	—	—	—	—	—	—	—
45	A	278107	Powder	11.7	4.58	0.90	3.02	0.21	0.01	0.75	0	—	0.46	—	—	—	0.16	0.41	.1067	19
46		—	Intended	12.0	4.5	1.0	1.1	—	—	1.0	—	—	0.80	—	—	—	—	—	—	—
46	A	278108	Powder	11.4	4.61	0.93	0.57	0.13	0.03	1.12	0.01	—	1.02	—	—	—	0.07	0.42	.1054	23
47		—	Intended	10.0	4.0	0.4	2.0	1.5	5.0	—	—	—	—	—	—	—	—	—	—	—
47	A	278109	Powder	9.82	4.20	0.42	2.05	1.57	4.56	0.03	0.01	—	—	—	—	—	0.13	0.25	.1086	27
48		—	Intended	15.5	4.7	—	1.75	—	—	—	—	—	—	—	—	—	—	—	—	—
48	A	278110	Powder	15.2	4.92	0.01	1.81	0.19	0.02	0.00	0.01	—	—	—	—	—	0.10	0.30	.1064	23
49		—	Intended	15.5	4.7	2.0	1.75	—	—	—	—	—	—	—	—	—	—	—	—	—
49	A	278111	Powder	14.8	4.92	1.77	1.71	0.16	0.00	0.00	0.00	—	—	—	—	—	0.10	0.28	.1080	22
49	C	283272	Powder	15.3	4.64	2.02	1.87	0.21	0.00	0.00	0.01	—	—	—	—	—	0.08	0.63	.1085	24
50		—	Intended	10.0	4.0	0.9	1.3	0.9	1.5	0.01	0.01	—	—	—	—	—	—	—	—	—
50	A	278112	Powder	9.80	4.02	0.78	1.10	1.00	1.34	0.01	0.01	—	—	—	—	—	0.09	0.81	.1053	22
50	C	283273	Powder	9.95	4.11	0.92	1.39	1.11	1.44	0.01	0.02	—	—	—	—	—	0.06	0.69	.1053	23
50	Special	284130	Powder	9.7	3.86	0.90	1.26	0.85	1.51	---	0.01	---	----	----	----	----	0.08	----	----	--
51		—	Intended	10.0	4.0	0.9	1.3	0.9	1.5	0.01	0.01	—	—	1.5	—	—	—	—	—	—
51	A	278113	Powder	9.55	4.12	0.75	1.23	1.02	1.37	0.01	0.01	—	—	1.34	—	—	0.08	0.75	.1059	22
52		—	Intended	10.0	4.0	0.9	—	—	—	0.01	0.01	—	—	1.5	—	—	—	—	—	—
52	A	278114	Powder	9.65	4.14	0.83	0.04	0.13	0.03	0.01	0.01	—	—	1.38	—	—	0.04	0.73	.1034	22
52	C	283274	Powder	9.79	4.01	0.92	0.01	0.14	0.01	0.01	0.02	—	—	1.49	—	—	0.06	0.75	.1033	24
52	Special	284131	Powder	10.1	4.0	0.93	--	0.1	0.02	---	---	----	0.01	1.49	----	----	0.3	----	----	--
53		—	Intended	10.0	4.0	—	2.4	1.3	4.9	0.04	0.04	—	—	—	—	—	—	—	—	—
53	A	278115	Powder	9.55	4.13	0.02	2.49	1.40	4.82	0.04	0.04	—	—	—	—	—	0.10	0.71	.1085	25
54		—	Intended	10.0	4.0	1.6	2.9	1.5	1.0	0.05	0.04	—	—	—	—	—	—	—	—	—
54	A	278116	Powder	9.45	3.98	1.39	2.88	1.61	0.89	0.05	0.04	—	—	—	—	—	0.11	0.60	.1070	23
55		—	Intended	10.0	4.0	1.6	1.0	1.7	2.6	0.07	0.05	—	—	—	—	—	—	—	—	—
55	A	278117	Powder	9.92	4.18	1.47	0.86	1.85	2.41	0.07	0.05	—	—	—	—	—	0.07	0.73	.1071	23

(Continued)

TABLE I (Cont'd.)

Alloy No.	Series	S. No.	Material Analyzed	Composition, % Zn	Mg	Cu	Mn	Fe	Ni	Cr	Ti	V	Zr	Co	Mo	W	Si	Al_2O_3(a)	Powder Density lb/in.^{3} (b)	Powder Size MMD - microns
56		—	Intended	10.0	4.0	1.8	1.9	—	2.6	0.11	0.07	—	—	—	—	—	—	—	—	—
56	A	278118	Powder	9.76	4.28	1.67	1.99	0.21	2.50	0.11	0.07	—	—	—	—	—	0.09	0.66	.1065	22
57		—	Intended	10.0	4.0	2.1	1.9	1.3	2.9	0.00	0.11	—	—	—	—	—	—	—	—	—
57	A	278119	Powder	9.55	4.02	1.92	2.00	1.24	2.58	0.00	0.10	—	—	—	—	—	0.08	0.75	.1081	25
58		—	Intended	10.0	4.0	2.7	2.0	1.3	3.6	0.04	—	—	—	—	—	—	—	—	—	—
58	A	278120	Powder	10.0	4.12	2.51	2.18	1.38	3.24	0.04	0.01	—	—	—	—	—	0.09	0.61	.1096	25
59		—	Intended	10.0	4.0	1.5	1.5	1.0	4.0	—	—	—	—	—	—	—	—	—	—	—
59	A	277918C	Powder	10.2	3.85	1.57	1.62	1.03	4.10	—	—	—	—	—	—	—	0.10	0.28	.1068	26
60		—	Intended	11.0	5.0	2.0	0.7	—	—	—	—	—	—	—	—	—	—	—	—	—
60	A	283674	Powder	11.6	5.50	1.82	0.72	0.13	—	—	—	—	—	—	—	—	0.05	0.33	.1035	33
61		—	Intended	10.0	4.0	0.9	—	—	—	—	—	—	—	—	—	—	—	—	—	—
61	A	283675	Powder	10.4	4.48	0.76	0.00	0.09	—	—	—	—	—	—	—	—	0.03	0.45	.1018	26
62		—	Intended	10.0	4.0	0.9	—	—	—	0.01	0.02	—	—	0.75	—	—	—	—	—	—
62	A	283925	Powder	10.0	4.03	0.94	—	—	—	0.01	0.03	—	—	0.76	—	—	—	0.31	.1022	42
63		—	Intended	10.0	4.0	0.9	—	—	—	0.01	0.02	—	—	2.50	—	—	—	—	—	—
63	A	283926	Powder	10.1	3.95	0.94	0.00	0.1	0.07	0.01	0.03	0.01	0.00	2.29	—	—	0.07	—	.1029	50
64		—	Intended	9.0	4.0	0.9	—	—	—	0.01	0.02	—	—	1.50	—	—	—	—	—	—
64	A	283927	Powder	8.9	4.06	0.94	—	—	—	0.01	0.03	—	—	1.50	—	—	—	0.31	.1024	48
65		—	Intended	11.0	4.0	0.9	—	—	—	0.01	0.02	—	—	1.50	—	—	—	—	—	—
65	A	283928	Powder	11.1	4.13	1.02	—	—	—	0.01	0.03	—	—	1.62	—	—	—	0.29	.1038	43
66		—	Intended	10.0	3.5	0.9	—	—	—	0.01	0.02	—	—	1.50	—	—	—	—	—	—
66	A	283929	Powder	10.0	3.56	0.94	—	—	—	0.01	0.03	—	—	1.51	—	—	—	0.30	.1034	43
67		—	Intended	10.0	4.5	0.9	—	—	—	0.01	0.02	—	—	1.50	—	—	—	—	—	—
67	A	283930	Powder	10.3	4.67	0.96	—	—	—	0.01	0.03	—	—	1.57	—	—	—	0.29	.1021	47
68		—	Intended	10.0	4.0	1.5	—	—	—	0.01	0.02	—	—	1.50	—	—	—	—	—	—
68	A	283931	Powder	9.9	3.87	1.50	0.00	0.1	0.06	0.01	0.03	0.01	0.00	1.51	—	—	0.06	—	.1033	37
69		—	Intended	10.0	4.0	0.5	—	—	—	0.01	0.02	—	—	1.50	—	—	—	—	—	—
69	A	283932	Powder	9.8	4.14	0.65	—	—	—	0.01	0.03	—	—	1.52	—	—	—	0.35	.1029	41
70		—	Intended	11.0	4.5	1.5	—	—	—	0.01	0.02	—	—	2.50	—	—	—	—	—	—
70	A	283933	Powder	10.8	4.64	1.31	—	—	—	0.01	0.03	—	—	2.42	—	—	—	0.31	.1047	42
71		—	Intended	9.0	3.5	0.5	—	—	—	0.01	0.02	—	—	0.75	—	—	—	—	—	—
71	A	283934	Powder	9.2	3.62	0.63	—	—	—	0.01	0.03	—	—	0.75	—	—	—	0.26	.1016	40
71	C	293303	Powder	9.29	3.58	0.54	—	—	—	0.02	0.02	—	—	0.68	—	—	—	0.45	.1020	23
72		—	Intended	10.0	4.0	0.9	—	—	—	0.01	0.02	—	—	1.50	—	—	0.5	—	—	—
72	A	283935	Powder	10.1	4.09	0.93	—	—	—	0.01	0.03	—	—	1.49	—	—	0.42	0.35	.1027	35

(Continued)

TABLE I (Cont'd.)

Alloy No.	Series	S. No.	Material Analyzed	Composition, % Zn	Mg	Cu	Mn	Fe	Ni	Cr	Ti	V	Zr	Co	Mo	W	Si	Al_2O_3(a)	Powder Density $lb/in.^3$(b)	Powder Size MMD-microns
73	A	284202	Powder	10.2	4.10	0.94	--	--	--	0.01	0.03	--	--	1.80	--	--	--	0.29	.1032	41
74	A	284203	Powder	9.8	4.14	1.36	--	--	--	0.01	0.03	--	--	1.26	--	--	--	0.34	.1033	44
75		--	Intended	6.8	2.7	2.0	--	1.0	5.0	0.3	--	--	--	--	--	--	--	--	--	
75	A	307586	Powder	7.06	2.79	2.04	0.01	0.93	4.72	0.28	0.01	--	--	--	--	--	0.08	0.55	.1056	31
76		--	Intended	6.8	2.7	2.0	--	3.0	7.0	0.3	--	--	--	--	--	--	--	--	--	
76	A	307587	Powder	6.72	2.68	2.08	0.02	3.51	6.74	0.38	0.01	--	0.03	0.01	--	--	0.05	0.62	.1098	31
77		--	Intended	6.8	2.7	2.0	1.0	--	--	0.5	--	--	--	--	--	--	--	--	--	
77	A	307588	Powder	7.03	2.71	2.08	1.06	0.16	0.07	0.68	0.01	0.01	--	--	--	--	0.07	0.54	.1022	35
78		--	Intended	6.8	2.7	2.0	3.0	--	--	1.0	--	--	--	--	--	--	--	--	--	
78	A	207589	Powder	7.06	3.11	2.12	2.84	0.21	0.03	0.84	0.01	0.01	0.01	--	--	--	0.1	0.60	.1035	37
79		--	Intended	6.8	2.7	2.0	1.0	--	--	0.5	--	--	0.1	--	--	--	--	--	--	
79	A	307590	Powder	6.85	2.76	2.06	1.02	0.15	0.01	0.52	0.01	0.01	0.1	--	--	--	0.2	0.61	.1023	31
80		--	Intended	6.8	2.7	2.0	3.0	--	--	1.0	--	--	0.4	--	--	--	--	--	--	
80	A	307591	Powder	7.12	2.72	2.11	2.88	0.14	0.2	1.02	0.01	0.01	0.5	--	--	--	0.05	0.50	.1043	33
81		--	Intended	6.8	2.7	2.0	1.0	--	5.0	0.5	--	--	0.1	--	--	--	--	--	--	
81	A	307592	Powder	6.96	2.74	2.12	1.02	0.16	4.49	0.58	0.01	0.01	0.1	0.01	--	--	0.05	0.59	.1060	34
82		--	Intended	6.8	2.7	2.0	3.0	--	7.0	1.0	--	--	0.4	--	--	--	--	--	--	
82	A	307593	Powder	6.92	2.68	2.11	2.86	0.13	7.12	1.28	0.01	0.01	0.5	0.01	--	--	0.05	0.48	.1103	34
83		--	Intended	6.8	2.7	2.0	1.0	1.0	5.0	0.5	--	--	0.1	--	--	--	--	--	--	
83	A	307594	Powder	6.85	2.65	2.06	1.02	1.25	4.52	0.43	0.01	0.01	0.09	0.01	--	--	0.2	0.57	.1065	35
84		--	Intended	6.8	2.7	2.0	3.0	3.0	7.0	1.0	--	--	0.4	--	--	--	--	--	--	
84	A	307595	Powder	6.74	2.72	2.08	2.88	3.05	6.54	1.08	0.01	0.01	0.3	0.01	--	--	0.05	0.51	.1129	29
85		--	Intended	7.8	2.5	1.0	--	2.0	5.0	0.2	--	--	--	--	--	--	--	--	--	
85	A	307596	Powder	7.58	2.55	1.14	0.02	2.16	4.75	0.00	0.01	0.01	--	0.01	--	--	0.08	0.59	.1060	33
86		--	Intended	7.8	2.5	1.0	--	4.0	2.5	0.2	--	--	--	--	--	--	--	--	--	
86	A	307597	Powder	7.55	2.55	1.11	0.02	4.04	2.12	0.14	0.01	0.01	--	0.01	--	--	0.05	0.55	.1061	36
87		--	Intended	7.8	2.5	1.0	--	2.0	2.5	0.2	--	--	--	--	--	--	--	--	--	
87	A	307598	Powder	7.58	2.52	1.06	0.02	2.16	2.26	0.16	0.01	0.01	--	0.01	--	--	0.05	0.63	.1043	37
88(c)		(c)	Intended	6.8	2.7	2.0	1.0	1.0	5.0	0.5	--	--		--	--	--	--	--	--	--
88	A	307599	Powder																	
89(c)		--(c)	Intended	7.8	2.5	1.0	--	2.0	2.5	0.2	--	--	--	--	--	--	--	--	--	--
89	A	307600	Powder																	
90	-	--	Intended	7.8	2.5	1.0	--	1.0	1.0	0.2	--	--	--	--	--	--	--	0.36	--	--
90	A	294013	Powder	7.52	2.44	1.00	0.01	1.08	1.00	0.20	0.00	0.00	--	--	--	--	0.02	--	.1030	44
		294013(c)		7.74	2.44	1.01	--	0.96	0.99	0.20	0.01	--	--	--	--	--	0.06	0.29	.1027	41

(a) The HCl technique was modified depending on the alloying elements present.
(b) Density by Pycnometer.
(c) Not prealloyed, but mixtures of elemental powders.

Table II

Properties of 2 in. Dia. Extrusions from Alloy Powders

Alloy No.	Ext. S-No.	Composition % (b) Zn	Mg	Cu	Mn	Fe	Ni	Cr	Ti	Other	Powder Size MMD - microns	Density, lb/in³	Location	Ultrasonic Rating (c,d)	Heat Treatment #1 (a) Longitudinal (c) T. S. ksi	Y.S. ksi	El. % in 4D	YS/Density x10⁶ in.	Transverse (c) T.S. ksi	Y.S. ksi	El. % in 4D	Heat Treatment #2 (h) Longitudinal T.S. ksi	Y.S. ksi	El. % in 4D	YS/Density x10⁶ in.
1	277373	9.9	3.5	1.1	0.5	-	-	-	-	-	44	.1028	Front	A+	106.8	104.2	2.1	1.014	88.6	(b)	0.0				
													Back	A+	107.2	(e)	2.1	-	63.4	(b)	1.6				
													Avg.		107.0		2.1	-	76.0		0.8				
2	277374	12.1	3.5	1.5	0.5	-	-	-	-	-	54	.1052	Front	A	105.8	103.5	2.9	0.984	75.9	(b)	0.0				
													Back	Failed	105.6	103.1	2.9	0.980	85.1	(b)	0.0				
													Avg.		105.7	103.3	2.9	0.982	80.5		0.0				
3	277375	12.3	4.0	1.6	0.5	-	-	-	-	-	27	.1052	Front	A+	106.7	104.0	1.4	0.988	84.3	(b)	(g)				
													Back	A+	105.6	103.1	0.7	0.980	90.9	(b)	0.0				
													Avg.		106.2	103.6	1.1	0.985	87.6						
4	277376	9.6	3.2	2.0	-	-	-	0.2	-	-	39	.1041	Front	A+	103.5	100.7	2.1	0.967	72.9	(b)	0.0				
													Back	A+	103.2	99.6	1.4	0.963	85.5	(b)	0.0				
													Avg.		103.4	100.2	1.8	0.965	79.2		0.0				
5	277377	10.3	2.9	2.1	1.8	-	-	0.1	-	-	37	.1062	Front	A+	103.8	101.0	1.4	0.951	70.6	(b)	0.0				
													Back	A+	107.4	103.7	1.4	0.976	89.9	(b)	0.0				
													Avg.		105.6	102.4	1.4	0.964	80.3		0.0				
6	277378	11.2	2.4	2.0	-	-	-	0.2	-	-	39	.1060	Front	A+	104.2	99.9	4.3	0.942	87.1	(b)	0.0	109.1	103.6	5.7	0.977
													Back	A+	103.7	98.9	3.6	0.933	89.0	35.7	1.9				
													Avg.		104.0	99.4	4.0	0.938	88.1		1.0				
7	277379	7.9	3.4	1.5	-	2.5	2.0	-	-	-	26	.1058	Front	A+	106.4	101.6	1.4	0.960	83.1	(b)	0.0				
													Back	A+	106.2	101.6	1.4	0.960	95.9	(b)	1.9				
													Avg.		106.3	101.6	1.4	0.960	89.5		1.0				
8	277380	7.9	3.5	1.5	1.6	1.6	1.4	-	-	-	44	.1057	Front	A	104.6	101.5	0.7	0.960	84.8	(b)	0.0				
													Back	Split	107.5	102.7	2.1	0.972	89.4	(b)	0.0				
													Avg.		106.1	102.1	1.4	0.966	87.1		0.0				
9	277381	7.9	3.5	1.6	-	-	-	0.5	0.4	V-0.4, Zr-0.4	38	.1037	Front	A+	98.8	93.3	2.9	0.900	(i)41.4	(b)	0.0				
													Back	A+	98.5	94.3	2.1	0.909	80.5	(b)	0.0				
													Avg.		98.7	93.8	2.5	0.904	80.5		0.0				

continued .....

Table II (Continued)

Alloy No.	Ext. S-No.	Composition, % (b) Zn	Mg	Cu	Mn	Fe	Ni	Cr	Ti	Other	Powder Size MMD - microns	Density, lb/in³	Location	Ultrasonic Rating (c,d)	Heat Treatment #1 (a) Longitudinal (c) T. S. ksi	Y. S. ksi	El. % in 4D	YS/Density x10⁶ in.	Transverse (e) T.S. ksi	Y.S. ksi	El. % in 4D	Heat Treatment #2 (h) Longitudinal Y.S. ksi	T.S. ksi	El. % in 4D	Y.S./Density x10⁶ in.
10	277382	7.9	3.5	1.5	-	-	-	2.1	0.9	V-1.7, Zr-0.9	39	.1065	Front	A	83.6	83.2	0.0	0.781	62.9	(b)	0.0				
													Back	A	85.4	85.4	0.0	0.802	63.2	(b)	0.0				
													Avg.		84.5	84.3	0.0	0.792	63.1		0.0				
11	277383	7.6	3.5	1.5	-	-	-	-	-	Co-1.4, Mo-1.6, W-0.5	37	.1047	Front	A+	97.8	94.2	0.7	0.900	71.3	(b)	0.0				
													Back	A+	97.5	95.2	0.7	0.909	80.3	(b)	0.0				
													Avg.		97.7	94.7	0.7	0.904	75.8		0.0				
12	277384	7.8	3.5	1.6	0.6	0.5	0.6	0.5	0.4	V-0.4, Zr-0.6, Co-0.5, Mo-0.5, W-0.5	41	.1061	Front	A+	97.4	94.1	0.7	0.887	77.5	(b)	0.0				
													Back	A+	98.6	95.1	0.7	0.896	86.6	(b)	0.0				
													Avg.		98.0	94.6	0.7	0.892	82.1		0.0				
13	277385	11.7	3.4	1.5	-	2.4	2.2	-	-	-	37	.1096	Front	A+	104.9	103.7	0.7	0.946	75.0	(b)	0.0				
													Back	A+	105.8	100.7	1.4	0.919	87.2	(b)	0.0				
													Avg.		105.4	102.2	1.1	0.932	81.1		0.0				
14	277386	11.8	3.5	1.5	1.6	1.6	1.5	-	-	-	35	.1098	Front	A+	107.0	102.7	0.7	0.935	84.4	(b)	0.0				
													Back	A+	106.3	102.2	0.7	0.931	81.5	(b)	0.0				
													Avg.		106.7	102.5	0.7	0.933	83.0		0.0				
15	277387	11.4	3.4	1.5	-	-	-	0.5	0.5	V-0.5, Zr-0.6	33	.1069	Front	A+	101.2	94.5	(g)	0.884	81.3	(b)	0.0				
													Back	A+	95.3	94.5	1.4	0.884	88.7	(b)	0.0				
													Avg.		98.3	94.5		0.884	85.0		0.0				
16	277388	12.0	3.5	1.5	-	-	-	2.2	1.1	V-1.9, Zr-1.0	44	.1104	Front	A+	82.4	(f)	0.0	-	57.1	(b)	0.0				
													Back	A+	82.5	(f)	0.0	-	61.9	(b)	0.0				
													Avg.		83.0		0.0	-	59.5		0.0				
17	277389	11.9	3.5	1.6	-	-	-	-	-	Co-[illegible].5, Mo-1.1, W-0.5	41	.1082	Front	A+	100.2	96.9	0.7	0.896	79.4	(b)	0.0				
													Back	A+	101.7	97.9	0.7	0.905	81.8	(b)	0.0				
													Avg.		101.0	97.4	0.7	0.900	80.6		0.0				
18	277390	11.7	3.4	1.5	0.6	0.5	0.6	0.5	0.5	V-0.4, Zr-0.5, Co-0.5, Mo-0.5, W-0.5	36	.1095	Front	A+	98.2	97.5	0.0	0.890	57.1 (i)	(b)	(g)				
													Back	A+	100.9	97.9	0.7	0.894	71.8	(b)	0.0				
													Avg.		99.6	97.7	0.4	0.892	71.8						
19	277391	7.5	3.0	1.7	-	-	-	-	-	-	42	.1018	Front	A+	101.9	95.9	6.4	0.942	84.1	(b)	0.0	105.8	101.2	7.1	0.984
													Back	A+	100.6	94.7	7.9	0.930	87.5	(b)	1.9				
													Avg.		101.3	95.3	7.2	0.936	85.8		1.0				

Continued . . .

Table II (Continued)

Alloy No.	Ext. S-No.	Composition, % (b) Zn	Mg	Cu	Mn	Fe	Ni	Cr	Ti	Other	Powder Size MMD - microns	Density, lb/in3	Location	Ultrasonic Rating (c, d)	Heat Treatment #1 (a) Longitudinal (c) T. S. ksi	Y. S. ksi	El. % in 4D	YS/Density x10^6 in.	Transverse (c) T.S. ksi	Y.S. ksi	El. in 4D	Heat Treatment #2 (k) Longitudinal T.S. ksi	Y.S. ksi	El. % in 4D	YS/Density x10^6 in.
20	277392	7.8	3.6	2.3	-	-	-	-	-	-	43	.1021	Front	A+	101.0	95.2	4.3	0.932	84.2	(b)	0.0	108.9	103.3	4.3	1.012
													Back	A+	99.6	94.4	3.6	0.924	90.3	(b)	3.7				
													Avg.		100.3	94.8	4.0	0.928	87.3		1.9				
21	277393	7.9	5.6	7.4	-	-	-	-	-	-	42	.1053	Front	A+	98.0	93.7	1.4	0.890	85.4	(b)	0.0				
													Back	A+	94.5	90.6	0.7	0.860	83.2	(b)	0.0				
													Avg.		96.3	92.2	1.1	0.875	84.3		0.0				
22	277394	7.9	8.4	14.9	-	-	-	-	-	-	48	.1100	Front	Failed	93.2	(f)	0.7	-	68.0	(b)	(g)				
													Back	A	93.7	(f)	0.0	-	70.3	(b)	0.0				
													Avg.		93.5		0.4	-	69.2						
23	277395	7.7	10.1	20.1	-	-	-	-	-	-	34	.1146	Front	None	72.2	(f)	(g)	-	17.2	(b)	0.0				
													Back	None	68.2	(f)	0.0	-	13.6	(b)	0.0				
													Avg.		70.2			-	15.4		0.0				
24	277396	7.8	7.2	20.0	-	-	-	-	-	-	27	.1167	Front	A+	79.1	(f)	0.0	-	74.5	(b)	0.0				
													Back	A+	83.8	(f)	0.0	-	82.4	(b)	(g)				
													Avg.		81.5		0.0	-	78.5						
25	277397	-	10.6	2.4	-	-	-	-	-	-	39	.0940	Front	A+	66.7	48.0	8.6	0.511	55.2	(b)	0.0				
													Back	A+	68.3	50.7	9.3	0.539	63.4	(b)	5.6				
													Avg.		67.5	49.4	9.0	0.525	59.3		2.8				
26	277398	3.0	7.4	2.3	-	-	-	-	-	-	50	.0957	Front	A+	69.2	50.5	6.4	0.528	60.1	(b)	5.6				
													Back	A+	67.6	49.2	7.9	0.514	60.4	47.9	5.6				
													Avg.		68.4	49.9	7.2	0.521	60.3		5.6				
27	277399	6.9	3.9	2.3	-	-	-	-	-	-	39	.1014	Front	A+	99.8	94.5	2.9	0.932	76.3	(b)	0.0				
													Back	A+	98.9	93.2	2.9	0.919	82.8	(b)	(g)				
													Avg.		99.4	93.9	2.9	0.926	79.6						
28	277400	9.8	3.8	2.3	-	-	-	-	-	-	34	.1042	Front	A+	102.7	99.9	2.9	0.959	89.0	(b)	0.0				
													Back	A+	101.2	97.7	2.1	0.938	89.2	(b)	1.9				
													Avg.		102.0	98.8	2.5	0.948	89.1		1.0				
29	277401	13.7	4.3	2.3	-	-	-	-	-	-	42	.1069	Front	A+	108.2	104.8	1.4	0.980	84.9	(h)	0.0				
													Back	A+	106.3	101.8	1.4	0.952	90.8	(h)	1.9				
													Avg.		107.3	103.3	1.4	0.966	87.9		1.0				

continued . . . .

Table II (Continued)

Alloy No.	Ext. S-No.	Zn	Mg	Cu	Mn	Fe	Ni	Cr	Ti	Other	Powder Size MMD microns	Density lb/in³	Location	Ultrasonic Rating (c, d)	HT #1 (a) Longitudinal (c) T. S. ksi	Y. S. ksi	El. % in 4D	YS/Density x10⁶ in.	HT #1 (a) Transverse (c) T.S. ksi	Y.S. ksi	El. % in 4D	HT #2 (k) Longitudinal T.S. ksi	Y.S. ksi	El. % in 4D	YS/Density x10⁶ in.
30	277402	7.9	14.6	-	-	-	-	-	-	-	27	.0941	Front	Split	67.9	57.1	2.1	0.607	56.9	(b)	0.0				
													Back	Split	64.2	56.9	1.4	0.605	55.5	(b)	0.0				
													Avg.		66.1	57.0	1.8	0.606	56.2		0.0				
31	277403	2.9	14.6	2.3	-	-	-	-	-	-	31	.0935	Front	A+	64.9	51.9	(g)	0.555	54.5	(b)	1.9				
													Back	A+	65.3	53.4	1.4	0.571	56.2	(b)	0.0				
													Avg.		65.1	52.7		0.564	55.4		1.0				
32	277404	6.6	2.7	0.6	-	-	2.3	0.1	-	-	44	.1025	Front	A+	96.8	92.4	5.7	0.901	79.3	(b)	0.0	100.5	96.9	5.0	0.945
													Back	A+	97.2	92.7	5.0	0.904	81.8	(b)	0.0				
													Avg.		97.0	92.6	5.4	0.903	80.6		0.0				
33	277405	9.0	3.5	1.2	1.1	-	-	-	-	-	41	.1032	Front	A+	107.7	104.0	2.1	1.007	81.8	(b)	(g)				
													Back	A+	108.2	104.4	1.4	1.012	82.9	(b)	0.0				
													Avg.		108.0	104.2	1.8	1.009	82.4						
34	277406	7.8	2.5	1.0	-	3.9	5.3	0.2	-	-	44	.1069	Front	A+	104.4	102.5	0.7	0.941	90.6	(b)	(g)				
													Back	A+	106.6	106.5	0.7	0.977	98.9	(b)	(g)				
													Avg.		105.5	104.5	0.7	0.959	94.8						
35	277407	9.0	3.4	1.2	2.5	-	-	-	-	-	45	.1038	Front	A+	106.5	102.7	(g)	0.989	77.1	(b)	0.0				
													Back	Failed	107.5	103.7	0.7	0.999	88.1	(b)	0.0				
													Avg.		107.0	103.2		0.994	82.6		0.0				
36	277424	10.7	3.8	2.0	1.7	-	-	-	-	-	35	.1076	Front	Failed	109.4	106.9	1.4	0.994	73.1	(b)	(g)	116.5(l)	115.9(l)	1.1(l)	1.077(l)
													Back	A	108.3	105.2	1.4	0.978	86.1	(b)	(g)				
													Avg.		108.9	106.1	1.4	0.986	79.6						
37	277425	8.4	3.5	-	2.1	3.3	6.0	-	-	-	43	.1128	Front	None	105.8	(f)	(g)	-	68.3	(b)	0.0				
													Back	None	93.9	(f)	0.0	-	65.9	(b)	0.0				
													Avg.		99.9				67.1		0.0				
38	277426	8.4	3.6	-	1.0	0.8	2.8	-	-	-	39	.1071	Front	A+	112.3	109.7	(g)	1.024	96.3	(b)	0.0	119.6(m)	117.0(m)	1.2(m)	1.092(m)
													Back	A+	111.6	108.9	(g)	1.016	98.0	(b)	0.0				
													Avg.		112.0	109.3		1.020	97.2		0.0				
39	277557	10.9	4.9	2.0	1.7	-	-	-	-	-	35	.1068	Front	A+	110.7	107.0	0.9	1.001	59.5	(f)	0.0				
													Back	A+	109.2	105.0	0.6	0.983	68.0	(f)	0.0				
													Avg.		110.0	106.0	0.8	0.992	63.8		0.0				

continued . . . .

Table II (Continued)

Alloy No.	Ext. S-No.	Zn	Mg	Cu	Mn	Fe	Ni	Cr	Ti	Other	Powder Size MMD - microns	Density lb/in3	Location	Ultrasonic Rating (c, d)	HT #1 (a) Longitudinal (c) T. S. ksi	Y. S. ksi	El. % in 4D	YS/Density x10^6 in.	HT #1 (a) Transverse (c) T.S. ksi	Y.S. ksi	El. % in 4D	HT #2 (κ) Longitudinal T.S. ksi	Y.S. ksi	El. % in 4D	YS/Density x10^6 in.
40	277428	8.4	5.2	-	1.0	0.7	3.0	-	-	-	42	.1059	Front	A	108.0	104.3	0.7	0.985	81.4	(h)	(g)				
													Back	Failed	102.5	99.1	0.7	0.936	84.6	(h)	1.9				
													Avg.		105.3	101.7	0.7	0.960	83.0						
41	273040	8.0	4.6	-	-	-	-	2.9	-	-	28	.1027	Front	A+	90.5	85.9	2.1	0.836	70.1	(f)	0.0	97.9	94.2	1.4(d)	0.918
													Back	A+	93.5	89.4	2.1	0.870	86.1	82.7	0.0				
													Avg.		92.0	87.7	2.1	0.854	78.1		0.0				
42	278041	7.6	3.9	-	-	-	-	2.0	-	-	32	.1022	Front	A+	91.4	88.4	0.7	0.865	68.0	(f)	0.0	97.4	95.2	(e)	0.931
													Back	A+	90.7	(f)	0.0	-	81.0	(f)	0.0				
													Avg.		91.1		0.4	-	74.5		0.0				
43	278241	12.0	4.7	0.9	0.9	-	-	0.20	-	Zr-0.2	18	.1056	Front	A+	104.6	101.1	0.9	0.957	73.9	(f)	0.0	114.6	110.7	1.1	1.048
													Back	A+	103.6	99.9	1.4	0.946	88.1	88.0	0.0				
													Avg.		104.1	100.5	1.2	0.952	81.0		0.0				
44	278242	11.2	5.0	0.9	2.5	-	-	0.23	-	Zr-0.9	20	.1072	Front	A+	102.2	(f)	0.0	-	71.3	(f)	0.0	111.9	(f)	0.0	---
													Back	A+	96.7	(f)	0.0	-	80.8	(f)	0.0				
													Avg.		99.5		0.0	-	76.1		0.0				
45	278243	11.7	4.6	0.9	3.0	-	-	0.75	-	Zr-0.5	19	.1062	Front	A+	98.5	(f)	0.0	-	76.3	(f)	0.0	10[illegible].9	102.4	0.7	0.946
													Back	A+	104.0	100.5	0.7	0.929	81.7	(f)	0.0				
													Avg.		101.3		0.4	-	79.0		0.0				
46	278244	11.4	4.6	0.9	0.6	-	-	1.12	-	Zr-1.0	23	.1069	Front	A+	98.8	94.5	0.9	0.884	83.7	(f)	0.0	108.1	104.8	1.1	0.980
													Back	A+	100.2	96.7	0.7	0.904	92.0	89.5	0.0				
													Avg.		99.5	95.6	0.8	0.894	87.9		0.0				
47	278245	9.8	4.2	0.4	2.1	1.6	4.6	-	-	-	27	.1101	Front	A+	82.7	(f)	0.0	-	63.9	(f)	0.0	89.1	(f)	0.0	---
													Back	A+	105.1	(f)	0.0	-	82.8	(f)	0.0				
													Avg.		93.9		0.0	-	73.4		0.0				
48	278246	15.2	4.9	-	1.8	-	-	-	-	-	23	.1078	Front	A+	105.5	101.8	0.8	0.944	76.[illegible]	(f)	0.0	112.0	108.0	0.6	1.002
													Back	A+	105.8	102.3	0.6	0.949	91.1	90.9	0.0				
													Avg.		105.7	102.1	0.7	0.947	83.7		0.0				
49	278247	14.8	4.9	1.8	1.7	-	-	-	-	-	21	.1095	Front	A+	102.9	(f)	0.0	-	71.6	(f)	0.0	11[illegible].9	116.2	0.[illegible]	1.0[illegible]1
													Back	A+	106.3	103.0	0.7	0.941	85.3	(f)	0.0				
													Avg.		104.6		0.4	-	78.5		0.0				

continued . . .

Table II (Continued)

Alloy No.	Ext. A-No.	Zn	Mg	Cu	Mn	Fe	Ni	Cr	Ti	Other	Powder Size MMD, microns	Density, lb/in^3	Location	Ultrasonic Rating (c, d)	HT #1 Long. (c) T. S. ksi	HT #1 Long. Y. S. ksi	HT #1 Long. El. % in 4D	HT #1 Long. YS/Density x10^6 in.	HT #1 Transverse (e) T.S. ksi	HT #1 Transv. Y.S. ksi	HT #1 Transv. El. % in 4D	HT #2 (k) Long. T. S. ksi	HT #2 Long. Y. S. ksi	HT #2 Long. El. % in 4D	HT #2 Long. YS/Density x10^6 in.
50	278248	9.8	4.0	0.8	1.1	1.0	1.3	0.01	0.01	-	22	.1068	Front	A+	106.8	103.3	1.1	0.957	79.5	(f)	0.0	118.4	115.0	0.9	1.077
													Back	A+	108.6	104.1	1.1	0.975	93.5	(f)	0.0				
													Avg.		107.7	103.7	1.1	0.971	86.4		0.0				
51	278249	9.6	4.1	0.8	1.2	1.0	1.4	0.01	0.01	Co-1.3	22	.1074	Front	A+	107.7	104.0	0.9	0.968	82.5	(f)	0.0	110.4	107.4	0.4(g)	1.000
													Back	A+	107.9	103.6	0.9	0.965	95.1	(f)	0.0				
													Avg.		107.8	103.8	0.9	0.966	88.8		0.0				
52	278250	9.7	4.1	0.8	-	-	-	0.01	0.01	Co-1.4	22	.1048	Front	A+	105.8	102.3	1.8	0.976	91.1	89.9	0.6	108.7	103.8	2.3	0.990
													Back	A+	105.8	102.8	[illegible]	0.981	94.1	90.3	0.4				
													Avg.		105.8	102.6	[illegible]	0.979	92.6	90.1	0.5				
53	278251	9.6	4.1	-	2.5	1.4	4.8	0.04	0.04	-	25	.1100	Front	A+	95.9	(f)	0.0	-	57.0(i)	(f)	0.0	99.6	(f)	0.0	---
													Back	A+	101.7	(f)	0.0	-	86.4	(f)	0.0				
													Avg.		98.8		0.0	-	86.4	-	0.0				
54	278252	9.5	4.0	1.4	2.9	1.6	0.9	0.05	0.04	-	23	.1085	Front	A+	104.6	104.1	0.1	0.959	74.8	(f)	0.0	110.3	(f)	0.0	---
													Back	A+	106.1	103.9	0.5	0.958	91.5	(f)	0.0				
													Avg.		105.4	104.0	0.3	0.958	83.2		0.0				
55	278253	9.9	4.2	1.5	0.9	1.9	2.4	0.07	0.05	-	23	.1086	Front	A+	105.1	101.6	0.7	0.935	69.9	(f)	0.0	109.2	(f)	0.0	---
													Back	A+	106.9	102.4	0.6	0.943	86.8	(f)	0.0				
													Avg.		106.0	102.0	0.7	0.949	78.4		0.0				
56	278254	9.8	4.3	1.7	2.0	-	2.5	0.11	0.07	-	22	.1080	Front	A+	105.6	102.1	0.7	0.945	84.2	(f)	0.0	111.5	107.5	0.7	0.995
													Back	A+	106.7	101.2	1.1	0.937	94.8	(f)	0.0				
													Avg.		106.2	101.7	0.9	0.942	89.5		0.0				
57	278255	9.6	4.0	1.9	2.0	1.2	2.6	-	0.10	-	25	.1096	Front	A+	104.9	104.3	0.4	0.952	82.5	(f)	0.0	114.7	110.7	(e)	1.010
													Back	A+	107.2	103.3	(g)	0.942	86.4	(f)	0.0				
													Avg.		106.1	103.8		0.947	84.5		0.0				
58	278256	10.0	4.1	2.5	2.2	1.4	3.2	0.04	-	-	25	.1111	Front	A+	102.3	(f)	0.0	-	59.4(i)	(f)	0.0	106.8	(f)	0.0	---
													Back	A+	104.6	(f)	0.0	-	85.8	(f)	0.0				
													Avg.		103.5		0.0	-	85.8		0.0				
59	278257	10.2	3.9	1.6	1.6	1.0	4.1	-	-	-	26	.1083	Front	A+	96.4	(f)	0.0	-	61.3	(f)	0.0	83.9	(f)	0.0	---
													Back	A+	102.1	(f)	0.0	-	74.6	(f)	0.0				
													Avg.		99.3		0.0	-	68.0		0.0				
[illegible]	283758	11.6	5.5	1.8	0.7	-	-	-	-	-	33	.1049	Front	A+	106.3	104.2	1.9	0.993	84.8	84.8	0.4(j)				
													Back		-	-	-	-	79.9	(f)	0				
													Avg.		-	-	-	-	82.4	-	0.2				
61	283759	10.4	4.5	0.8	-	-	-	-	-	-	26	.1032	Front	A+	109.1	106.3	3.0	1.030	91.1	87.2	0.9				
													Back		108.9	106.3	3.4	1.030	91.6	87.7	(g)				
													Avg.		109.0	106.3	3.2	1.030	91.4	87.4	-				

continued . . .

Table II (Continued)

Alloy No.	S-No.	Zn	Mg	Cu	Mn	Fe	Ni	Cr	Ti	Other	Powder Size MMD-microns	Density lb/in³	Location	Ultrasonic Rating (c, d)	HT #1 (a) Longitudinal (c) T. S. ksi	Y. S. ksi	El. % in 4D	YS/Density x10⁶ in.	HT #1 (a) Transverse (c) T.S. ksi	Y.S. ksi	El. % in 4D	HT #2 (k) Longitudinal T. S. ksi	Y. S. ksi	El. % in 4D	YS/Density x10⁶ in.
62	307310	10.0	4.0	0.9	-	-	-	.01	.03	Co-0.8	42	.1036	Front	A+	106.8	(b)	2.9	-	95.6	(b)	1.0	116.2	113.7	2.1	1.097
													Front		107.2	103.2	2.9	0.996	86.7	(f)	0.7				
													Back		107.9	(h)	2.6	-	92.7	(h)	0.7				
													Back		107.5	103.5	2.1	0.999	91.1	90.6	0.8				
													Avg.		107.4	103.4	2.6	0.998	91.5	-	0.8				
63	307311	10.1	4.0	0.9	-	-	-	.01	.03	Co-2.3	50	.1043	Front	+	101.6	(h)	0.0	-	73.2	(h)	0	113.7	107.7	0.4	1.032
													Front		103.6	100.1	0.6	0.960	81.3	(h)	0				
													Back		104.8	(h)	0.8	-	77.9	(h)	0				
													Back		105.7	102.5	0.9	0.983	81.1	(h)	0				
													Avg.		103.9	101.3	0.6	0.971	78.4	-	0				
64	307312	8.9	4.1	0.9	-	-	-	.01	.03	Co-1.5	48	.1038	Front	A+	104.8	(h)	1.9	-	91.3	(h)	1.0	118.0	115.1	1.1	1.090
													Front		105.5	101.0	2.8	0.973	94.1	89.4	1.3				
													Back		104.7	(h)	1.8	-	86.9	(h)	0.7				
													Back		104.3	100.9	1.4	0.972	92.3	91.4	1.0				
													Avg.		104.8	101.0	2.0	0.973	91.2	90.4	1.0				
65	307313	11.1	4.1	1.0	-	-	-	.01	.03	Co-1.6	43	.1052	Front	A+	108.1	(h)	1.9	-	84.6	(b)	0	118.7	116.2	0.9	1.104
													Front		109.2	105.2	1.5	1.000	94.8	92.6	0.7				
													Back		107.6	(h)	1.2	-	87.3	(h)	0.4				
													Back		112.4	107.1	1.5	1.018	92.3	90.5	0.6				
													Avg.		109.3	106.2	1.5	1.010	89.8	91.6	0.4				
66	307314	10.0	3.6	0.9	-		-	.01	.03	Co-1.5	43	.1048	Front	A+	108.3	(h)	2.1	-	96.9	(h)	0.7(j)	116.9	113.3	2.1	1.081
													Front		108.5	104.5	2.0	0.997	81.5	(f)	0				
													Back		107.1	(h)	1.9	-	91.1	(h)	0.9				
													Back		109.0	105.8	2.9	1.010	33.7(i)	(f)	0				
													Avg.		108.2	105.2	2.2	1.004	89.8	-	0.2				
67	307315	10.3	4.7	1.0	-	-	-	.01	.03	Co-1.6	47	.1035	Front	A+	104.6	(h)	1.6	-	87.9	(b)	(g)	112.4	107.6	1.4	1.040
													Front		108.2	101.8	1.2	0.984	86.6	(f)	0.4				
													Back		106.8	(h)	2.9	-	81.7	(h)	0				
													Back		109.6	104.1	2.0	1.006	84.6	(h)	0				
													Avg.		107.3	103.0	1.9	0.995	85.2	-	-				

continued . . .

Table II (Continued)

Alloy No.	Ext. S-No.	Composition % (b) Zn	Mg	Cu	Mn	Fe	Ni	Cr	Ti	Other	Powder Size AMD. Microns	Density lb/in³	Location	Ultrasonic Rating (c, d)	Heat Treatment #1 (a) Longitudinal (c) T. S. ksi	Y. S. ksi	El. % in 4D	YS/Density x10⁶ in.	Transverse (c) T.S. ksi	Y.S. ksi	El. % in 4D	Heat Treatment #2 (k) Longitudinal T. S. ksi	Y. S. ksi	El. % in 4D	YS/Density x10⁶ in.
68	307316	9.9	3.9	1.5	-	-	-	.01	.03	Co-1.5	37	.1047	Front	A+	104.3	(h)	1.4	-	87.8	(b)	0.3(j)	114.8	110.0	1.6	1.051
													Front		106.5	100.2	1.4	0.957	85.8	(f)	0.4				
													Back		107.1	(h)	2.1	-	91.5	(b)	0.7				
													Back		106.6	102.4	1.5	0.978	87.3	(f)	0.4				
													Avg.		105.9	101.3	1.6	0.968	88.1	-	0.4				
69	307317	9.8	4.1	0.6	-	-	-	.01	.03	Co-1.5	41	.1043	Front	A+	107.9	(h)	1.9	-	91.9	(b)	(g)	120.8	116.5	1.2	1.117
													Front		108.4	103.9	1.8	0.996	93.3	(f)	(g)				
													Back		107.3	(h)	1.0	-	88.0(i)	(b)	0				
													Back		111.9	105.6	1.5	1.012	84.0	(b)	0				
													Avg.		108.9	104.8	1.6	1.005	89.7	-	-				
70	307318	10.8	4.6	1.3	-	-	-	.01	.03	Co-2.4	42	.1062	Front	A+	105.9	(h)	1.0	-	77.0	(b)	0	121.3	117.3	0.4	1.104
													Front		108.1	103.6	0.9	0.976	83.6	(b)	0				
													Back		109.2	(h)	0.6	-	91.0	(b)	(g)				
													Back		110.6	106.1	0.9	0.999	91.6	(f)	(g)				
													Avg.		108.4	104.8	0.8	0.987	85.8	-	-				
71	307319	9.2	3.6	0.6	-	-	-	.01	.03	Co-0.8	40	.1030	Front	A+	106.9	(h)	3.9	-	94.6	(b)	1.3	115.3	112.0	3.6	1.087
													Front		110.1	104.3	2.3	1.013	93.3	91.2	0.7				
													Back		107.7	(h)	1.9	-	93.4	(b)	0.9				
													Back		110.6	105.6	4.3	1.025	86.9	(f)	0.2				
													Avg.		108.8	105.0	3.1	1.012	92.0	-	0.8				
72	307320	10.1	4.1	0.9	-	-	-	.01	.03	Co-1.5, Si-0.4	35	.1044	Front	A+	104.9	(h)	1.5	-	94.9	(b)	0.7(j)	116.9	113.4	0.8	1.086
													Front		108.1	102.1	1.7	0.978	98.0	91.9	1.2				
													Back		105.9	(h)	0.8	-	91.6	(b)	0.6(j)				
													Back		110.1	103.9	1.4	0.995	88.6	(f)	0.3				
													Avg.		107.2	103.0	1.4	0.986	93.3	-	0.7				
75	293184	7.1	2.8	2.0	-	1.0	4.7	0.3	-	-	31	.1071	Front	A+	101.4	98.1	0.6	0.916	89.6	(f)	(g)				
													Back		100.2	97.6	0.6	0.911	87.3	(f)	(g)				
													Avg.		100.8	97.8	0.6	0.913	88.4	-	-				
79	293188	6.8	2.8	2.1	1.0	-	-	0.5	-	0.1 Zr	31	.1037	Front	A+	97.2	87.9	3.9	0.848	90.2	81.6	3.4				
													Back		96.3	88.8	2.7	0.856	-	-	-				
													Avg.		96.8	88.4	3.3	0.852	90.2	81.6	3.4				

Table II (Continued)

Alloy No.	S.No.	Composition, % (b) Zn	Mg	Cu	Mn	Fe	Ni	Cr	Ti	Other	Powder Size MMD - microns	Density, lb/in.³	Location	Ultrasonic Rating (c,d)	Heat Treatment #1 (a) Longitudinal (c) T.S. ksi	Y.S. ksi	El. % in 4D	YS/Density x10⁶ in.	Transverse (c) T.S. ksi	Y.S. ksi	El. % in 4D
82	293191	6.9	2.7	2.1	2.9	-	7.1	1.3	-	0.5 Zr	34	.1119	Front	A+	92.6	(f)	0	-	82.4	(f)	(g)
													Back		98.3	(f)	0	-	81.7	(f)	(g)
													Avg.		95.4	-	0	-	82.0	-	-
83	293192	6.8	2.6	2.1	1.0	1.2	4.5	0.4	-	0.1 Zr	35	.1080	Front	A+	101.2	96.6	0.6	0.894	96.9	91.7	1.0
													Back		99.7	95.6	0.6	0.885	86.5	(f)	(g)
													Avg.		100.4	96.1	0.6	0.890	91.7	-	-
85	293194	7.6	2.6	1.1	-	2.2	4.8	0.0	-	-	33	.1075	Front	A+	88.5	83.7	1.7	0.779	81.5	76.0	1.3
													Back		88.2	83.4	1.3	0.776	81.1	75.8	1.2
													Avg.		88.4	83.6	1.5	0.777	81.3	75.9	1.3
86	293195	7.6	2.6	1.1	-	4.0	2.1	0.1	-	-	36	.1076	Front	A+	107.4	101.3	1.3	0.941	88.5	(f)	0.3
													Back		106.8	100.9	0.7	0.938	94.9	91.0	0.6
													Avg.		107.1	101.1	1.0	0.940	91.7	-	0.4
87	293196	7.6	2.5	1.1	-	2.2	2.3	0.2	-	-	37	.1058	Front	A+	104.1	99.1	1.7	0.937	97.6	91.3	1.5
													Back		103.7	99.3	1.0	0.938	92.2	92.2	0.7
													Avg.		103.9	99.2	1.4	0.938	[illegible]	91.8	1.1
90	294014	7.5	2.4	1.0	-	1.1	1.0	0.2	-	-		.1044	Front	A+	98.8	92.4	5.4	0.885	87.6	80.5	2.4
													Back		99.1	93.6	5.4	0.897	86.5	80.7	2.3
													Avg		99.0	93.0	5.4	0.891	87.0	80.6	2.4

(a) Heat Treatment #1 - SHT 2 hrs at 860°F, CWQ, aged 24 hrs at 250°F-2" dia.

(b) Based on analysis of powder or extrusion.

(c) One test per value of heat treated rod to Alloy 59. The tests from 60-90 are for as extruded material.

(d) A+ = met standards higher than Class A. A = met Class A Standards. Failed = Class A standards not met. Split = rod cracked during CWQ. None = not measured due to rough surface.

(e) Not measured.

(f) Failed before reaching 0.2% offset.

(g) Not obtained - specimen shattered.

(h) Strain follower not used to avoid breaking it

(i) Data not included in average.

(j) Failed outside gauge length.

(k) Heat Treatment #2 - SHT 1/2 hr at 920°F, CWQ, aged 96 hrs at 225°F - 1" x 1" quadrants.

(l) S.No. 277645.

(m) S.No. 277646.

TABLE III

COMPOSITIONS IN VARIOUS PHASE FIELDS OF THE Al-Zn-Mg-Cu SYSTEM AT 860°F (460°C)

Alloy No.	% Zn	% Mg	% Cu	Phase Field*
19	7.6	3.0	1.5	α + S + T + M
20	7.9	3.6	2.3	α + S + T + M
21	8.0	5.6	7.5	α + S + T + M
22	8.0	8.5	15.0	α + S + T + M
23	8.0	10.3	20.0	α + S + T + M
24	8.0	7.5	20.0	α + S + Z + M
25	---	10.8	2.3	α + S + T
26	3.0	7.5	2.3	α + S + T
27	7.0	4.0	2.3	α + S + T
28	10.0	4.0	2.3	α + M + T
29	14.0	4.4	2.3	α + M + T
30	8.0	15.0	---	α + T
31	3.0	15.0	2.3	α + T

* Phase identification

α = Al

S = α(Al-Cu-Mg)

T = {α(Al-Mg-Cu), Mg-Zn-Al} isomorphous

M = {β(Zn-Mg) or $MgZn_2$, γ(Al-Cu-Mg)} isomorphous

[illegible] = {α(Zn-Mg), β(Al-Cu-Mg)} isomorphous

TABLE IV

COMPARISON OF DENSITY OF POWDERS AND EXTRUSIONS

Alloy No.	S. No.	Location	Powder Density, gm/cc (b)	Extrusion Density, gm/cc (c)	Difference in Densities, gm/cc (ED-PD)	Variation in Density, % [(ED-PD)/ED]x100
39 (a)	283462	F	2.894	2.9304	.036	1.2
"	"	F	2.894	2.9315	.038	1.3
"	"	B	2.894	2.9298	.036	1.2
"	"	Avg.	2.894	2.9306	.037	1.2
50 (a)	283481	F	2.914	2.9465	.032	1.1
"	"	F	2.914	2.9459	.032	1.1
"	"	B (d)	2.914	2.9481	.034	1.2
"	"	Avg.	2.914	2.9468	.033	1.1
52 (a)	283492	F	2.858	2.8974	.039	1.3
"	"	F	2.858	2.8979	.040	1.4
"	"	B	2.858	2.8975	.038	1.3
"	"	Avg.	2.858	2.8970	.039	1.3
52 (e)	307454	F	2.855	2.9007	.046	1.6
"	"	FM	2.855	2.9005	.046	1.6
"	"	M	2.855	2.9010	.046	1.6
"	"	BM	2.855	2.8998	.045	1.6
"	"	B	2.855	2.8992	.044	1.6
"	"	Avg.	2.855	2.9001	.045	1.6
52 (e)	307455	F	2.855	2.8978	.043	1.5
"	"	B	2.855	2.8977	.043	1.5
"	"	Avg.	2.855	2.8978	.043	1.5
62 (e)	307321	F	2.830	2.8785	.048	1.7
"	"	B	2.830	2.8772	.047	1.6
"	"	Avg.	2.830	2.8778	.048	1.7
64 (e)	307323	F	2.833	2.8770	.044	1.5
"	"	B	2.833	2.8764	.043	1.5
"	"	Avg.	2.833	2.8767	.044	1.5
71 (e)	307330	F	2.813	2.8566	.044	1.5
"	"	FM	2.813	2.8567	.044	1.5
"	"	M	2.813	2.8568	.044	1.5
"	"	BM	2.813	2.8565	.044	1.5
"	"	B	2.813	2.8568	.044	1.5
"	"	Avg.	2.813	2.8567	.044	1.5

(a) Two in. dia. tensile specimens SHT 1/2 hr. at 920°F, CWQ, aged 96 hrs. at 225°F.

(b) By pycnometer method on powders. (PD)

(c) By water displacement method on a, d, and e. (ED)

(d) Two in. dia. broken tensile specimens SHT 2 hrs. at 860°F, CWQ, aged 96 hrs. at 225°F.

(e) One in. x 4-1/4 in. extruded slab in -F temper. Location of specimens in sketch below.

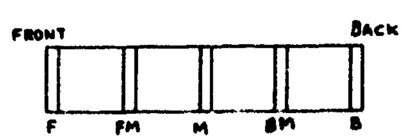


TABLE V

EFFECT OF HEAT TREATMENT CONDITIONS ON LONGITUDINAL TENSILE PROPERTIES (a) OF 2 IN. DIA. EXTRUDED ROD

S. No.	Composition, % (b) Zn	Mg	Cu	Mn	Fe	Ni	Cr	SHT(c) Hr.	°F	AGE Hr.	°F	T.S. ksi	Y.S. ksi	El. % in 4D	YS/Density x10⁶ in.
277557	10.9	4.9	2.0	1.7	—	—	—	2	920	96	225	122.4	118.0	(d)	1.105
								2	920	144	225	118.9	118.2	0.7	1.107
								2	860	24	250	110.7	107.0	0.9	1.002
277426	8.4	3.6	—	1.0	.8	2.8	—	2	860	96	225	118.5	115.8	1.0	1.081
								2	860	{6 +48}	{200 225}	118.8	115.3	0.9	1.076
								2	860	24	250	112.3	109.7	(d)	1.024
277424	10.7	3.8	2.0	1.7	—	—	—	2	920	144	225	117.9	114.7	1.9	1.066
								2	920	96	225	118.2	114.2	1.7	1.061
								2	860	24	250	109.4	106.9	1.4	0.993
277401	13.7	4.3	2.3	—	—	—	—	2	920	96	225	118.1	113.6	0.8	1.062
								2	920	144	200	117.4	113.1	1.4	1.058
								2	860	24	250	108.2	104.8	1.4	0.980
277373	9.9	3.5	1.1	.5	—	—	—	2	860	96	225	112.6	109.5	2.1	1.065
								2	920	144	200	112.9	109.4	2.7	1.064
								2	950	96	225	112.9	109.4	2.7	1.064
								2	860	24	250	106.8	104.2	2.1	1.014
277406	7.8	2.5	1.0	—	3.9	5.3	.2	2	860	96	225	112.3	(e)	0.3	—
								2	920	96	250	109.7	106.9	0.4	0.982
								2	860	24	250	104.4	102.5	0.7	0.941

(a) based on one tensile test on front of extrusion.
(b) based on analysis of powder or extrusion.
(c) quenched in cold water after solution heat treatment and before aging.
(d) not obtained - specimen shattered.
(e) specimen failed before reaching 0.2% offset.

TABLE VI

EFFECT OF HOLDING TIME AT THE SOLUTION HEAT TREATING TEMPERATURE ON TENSILE PROPERTIES

Alloy No.	Extr. S. No.	Composition, %						Density lb./in.^{3}	Compact Preheat		SHT(c)		Longitudinal			YS/Density x10^6 in.
		Zn	Mg	Cu	Mn	Fe	Ni		Hr.	°F	Time Hr.	Temp. °F	T.S. ksi	Y.S. ksi	El. % in 4D	
36	277645	10.7	3.8	2.0	1.7	—	—	0.1076	.75	850	.5	920	118.5	115.9	1.1	1.077
		10.7	3.8	2.0	1.7	—	—	"	.75	850	1.	920	118.6	115.0	(a)	1.069
		10.7	3.8	2.0	1.7	—	—	"	.75	850	2.	920	114.2	111.2	0.3(b)	1.033
38	277646	8.4	3.6	—	1.0	0.9	3.1	0.1071	1.5	850	.5	920	119.6	117.0	1.2	1.092
		8.4	3.6	—	1.0	0.9	3.1	"	1.5	850	1.	920	119.4	116.9	1.3	1.091
		8.4	3.6	—	1.0	0.9	3.1	"	1.5	850	2.	920	119.4	116.9	(a)	1.091

Note: Each result represents one tensile test.

(a) Not obtained. Specimen shattered.
(b) Specimen failed outside gage length.
(c) Quarter sections of 2 in. dia. rod from front of extrusions were solution heat treated, CWQ and aged immediately 96 hrs at 225°F.

Table VII

EFFECT OF COOLING RATE ON TENSILE PROPERTIES

Alloy No.	S. No.	Composition, % Zn	Mg	Cu	Mn	Cr	Fe	Ni	Ti	Co	Compact Preheat Temp., °F	Heat Treatment SHT t/T (a)	Quench (b)	Age t/T (a)	Specimen Size, in Dia.	Approx. (h) Cooling Rate, °F/Sec.	Longitudinal T.S. ksi	Y.S. ksi	El, % in 4D	Y.S./Density x 10⁶ in	Transverse T.S. ksi	Y.S. ksi	El, % in 4D
[illegible]	277378	11.2	2.4	2.0	---	0.2	---	---	---	---	900	2/860	CWQ	24/250	1x1(c)	350	108.4	104.9	4.3	0.990	----	----	----
													CWQ		2	150	104.2	99.9	4.3	0.942	----	----	----
[illegible]	277391	7.5	3.0	1.7	---	---	---	---	---	---	900	2/860	CWQ	24/250	1x1	350	104.3	98.4	7.1	0.966	----	----	----
													CWQ		2	150	101.9	95.9	6.4	0.942	----	----	----
[illegible]	277392	7.8	3.6	2.3	---	---	---	---	---	---	900	2/860	CWQ	24/250	1x1	350	104.3	99.9	4.3	0.978	----	----	----
													CWQ		2	150	101.0	95.2	4.3	0.932	----	----	----
[illegible]	277404	6.6	2.7	0.6	---	0.1	---	2.3	---	---	900	2/860	CWQ	24/250	1x1	350	97.4	94.2	4.3	0.919	----	----	----
													CWQ		2	150	96.8	92.4	5.7	0.901	----	----	----
[illegible]	2779[illegible]	10.6	4.4	2.0	1.7	---	---	---	---	---	550	2/860	CWQ	24/250	1x1/5/16(d)	350/1500(d)	107.0	104.9	0.8	0.991	64.0	(e)	0
													CWQ		2	150	102.4	99.5	0.9	0.940	70.5	(e)	0
	277939(f)												CWQ		1x1/5/16(d)	350/1500(d)	103.[illegible]	102.9	0.8	0.973	88.6	(e)	0
													CWQ		2	150	102.1	98.0	1.3	0.911	80.4	88.5	0.2
[illegible]	2779[illegible]	8.2	3.3	---	1.1	---	1.1	3.0	---	---	850	2/860	CWQ	24/250	1x1/5/16(d)	350/1500(d)	113.3	112.7	0.1	1.074	92.3	(e)	0
													CWQ		2	150	104.7	104.5	0.5	0.946	86.2	(e)	0
	277937(f)												CWQ		1x1/5/16(d)	350/1500(d)	113.6	111.2	0.6	1.060	96.4	(e)	0
													CWQ		2	150	102.7	100.3	1.3	0.956	93.1	(e)	0
	277936												CWQ	24/250 +10/330	1x1/5/16(d)	350/1500(d)	83.5	77.7	2.2	0.741	80.9	77.4	1.4
													CWQ		2	150	85.6	76.1	5.0	0.725	72.8	70.6	0.8
	277937(f)												CWQ		1x1/5/16(d)	350/1500(d)	85.0	77.0	3.6	0.734	82.2	76.6	1.8
													CWQ		2	150	82.9	74.4	3.4	0.709	73.9	70.3	1.2
	2779[illegible]												CWQ	24/250 +20/330	1x1/5/16(d)	350/1500(d)	79.0	67.3	5.0	0.642	74.0	66.8	2.0
													CWQ		2	150	79.8	68.2	6.8	0.650	73.4	64.6	2.6
	277937(f)												CWQ		1x1/5/16(d)	350/1500(d)	78.1	67.2	4.6	0.641	75.8	68.2	2.3
													CWQ		2	150	77.8	66.6	4.0	0.635	72.4	63.8	2.8
	2779[illegible]												CWQ	24/250 +40/330	1x1/5/16(d)	350/1500(d)	75.1	62.1	5.8	0.592	70.0	62.6	2.5
													CWQ		2	150	74.8	61.1	5.8	0.582	65.7	58.2	2.0
	277937(f)												CWQ		1x1/5/16(d)	350/1500(d)	74.1	61.2	6.4	0.583	72.0	61.4	2.9
													CWQ		2	150	73.4	60.1	5.8	0.573	66.5	57.4	2.6
[illegible]	29[illegible]462	10.9	4.9	2.0	1.8	---	---	---	---	---	950	0.5/920	CWQ	96/225	0.250	2000	122.5	120.2	0.8	1.133	----	----	----
													CWQ		2	150	112.8	120.2	0.0	1.053	----	----	----
													SWQ		0.250	23	109.7	111.7	1.2	0.995	----	----	----
													A		0.250	1.7	99.6	105.6	14	0.870	----	----	----
													A		2	0.21	62.5	48.5	3.3	0.457	----	----	----

Continued

Table VII (continued)

EFFECT OF COOLING RATE ON TENSILE PROPERTIES

Alloy No.	S. No.	Composition, % Zn	Mg	Cu	Mn	Cr	Fe	Ni	Ti	Co	Compact Preheat Temp, °F	Heat Treatment SHT t/T (a)	Quench (b)	Age t/T (a)	Specimen Size, in Dia.	Approx. (h) Cooling Rate, °F/Sec.	Longitudinal T.S. ksi	Y.S. ksi	El, % in 4D	Y.S./Density x 10⁶ in	Transverse T.S. ksi	Y.S. ksi	El, % in 4D
49	278247	14.8	4.9	1.8	1.7	---	---	---	---	---	900	0.5/920	CWSQ	96/225	0.250	25,000	118.1	(e)	(g)	----	----	----	----
													CWQ		0.250	2,000	121.3	(e)	(g)	----	----	----	----
													CWQ		1x1	350	116.9	116.2	0.5	1.061	----	----	----
													CWQ		2	150	112.9	(e)	0.0	----	----	----	----
													BWQ		0.250	23	106.7	101.2	0.8	0.924	----	----	----
	283471	15.3	4.6	2.0	1.9	---	---	---	---	---	900		CWQ		0.250	2,000	120.2	(e)	(g)	----	----	----	----
50	278248	9.8	4.0	0.8	1.1	0.1	1.0	1.3	0.01	---	900	0.5/920	CWSQ	96/225	0.250	25,000	127.5	124.4	(g)	1.165	----	----	----
													CWQ		0.250	2,000	127.5	124.0	1.2	1.161	----	----	----
													CWQ		0.750	500	118.9	115.6	1.0	1.083	----	----	----
													CWQ		1x1	350	118.4	115.0	0.9	1.077	----	----	----
													BWQ		0.250	23	102.0	94.8	2.0	0.888	----	----	----
													A		0.250	1.7	91.9	81.5	4.0	0.763	----	----	----
													A		2	0.21	63.3	45.8	4.3	0.429	----	----	----
	283481	10.0	4.1	0.9	1.4	0.01	1.1	1.4	0.02	---	900		CWQ		2	150	115.3	109.0	(g)	1.020	----	----	----
	283483	10.0	4.1	0.9	1.4	0.01	1.1	1.4	0.02	---	1000		CWQ		0.250	2,000	121.9	119.8	1.4	1.122	----	----	----
													CWQ		2	150	114.4	111.9	1.3	1.048	----	----	----
													BWQ		0.250	23	108.2	103.9	1.4	0.973	----	----	----
													A		0.250	1.7	99.3	93.5	1.4	0.875			
													A		2	0.21	63.6	51.6	2.4	0.485	----	----	----
52	278250	9.7	4.1	0.8	---	0.01	---	---	0.01	1.4	900	0.5/920	CWSQ	96/225	0.250	25,000	124.8	123.0	2.4	1.174	----	----	----
													CWQ		0.250	2,000	123.3	121.5	1.8	1.160	----	----	----
													CWQ		0.750	500	117.9	114.9	1.4	1.008	----	----	----
													CWQ		1x1	350	108.7	103.8	2.3	0.991	----	----	----
													BWQ		0.250	23	99.6	92.3	4.6	0.882	----	----	----
													A		0.250	1.7	89.4	80.9	6.0	0.773	----	----	----
													A		2	0.21	61.5	44.5	6.6	0.425	----	----	----
	283493	10.0	4.0	0.9	---	0.01	---	---	0.02	1.5	900		CWQ		0.250	2,000	124.0	121.6	2.8	1.163	----	----	----
													CWQ		2	150	115.4	111.2	(g)	1.062	----	----	----
	283495	10.0	4.0	0.9	---	0.01	---	---	0.02	1.5	1000		CWQ		0.250	2,000	122.0	119.4	1.8	1.039	----	----	----
													CWQ		2	150	115.1	111.1	1.9	1.060	----	----	----
													BWQ		0.250	23	104.1	102.0	2.2	0.973	----	----	----
													A		0.250	1.7	96.7	88.6	3.8	0.845	----	----	----
													A		2	0.21	61.9	46.0	8.6	0.439	----	----	----
59	277934	10.2	3.9	1.6	1.6	---	1.0	4.1	---	---	850	2/860	CWQ	24/250	1x1/5/16(d)	350/1500(d)	87.8	(e)	0.0	------	61.2	(e)	0
													CWQ		2	150	90.3	(e)	0	------	64.6	(e)	0
	277935(f)												CWQ		1x1/5/16(d)	350/1500(d)	109.2	107.9	(g)	0.996	91.5	(e)	0
													CWQ		2	150	101.5	102.9	0.3	0.950	85.0	(e)	0
60	283758	11.6	5.5	1.8	0.7	---	---	---	---	---	950	0.5/920	CWQ	96/225	0.250	2,000	111.1	110.7	0.8	1.055	----	----	----
													CWQ		2	150	107.9	------	0.3	------	----	----	----
													BWQ		0.250	23	105.5	103.9	0.9	0.990	----	----	----
													A		0.250	1.7	100.6	97.2	1.0	0.927	----	----	----
													A		2	0.21	58.1	47.2	2.2	0.450	----	----	----
63	283759	10.4	4.5	0.8	---	---	---	---	---	---	1000	0.5/920	CWQ	96/225	0.250	2,000	119.5	115.9	2.6	1.123	----	----	----
													CWQ		2	150	114.9	111.0	2.9	1.076	----	----	----
													BWQ		0.250	23	109.4	103.7	3.3	1.005	----	----	----
													A		0.250	1.7	98.4	91.1	4.6	0.883	----	----	----
													A		2	0.21	63.6	47.3	9.3	0.458	----	----	----

NOTE:
(a) t - time in hours, T - temperature in °F
(b) CWSQ - Cold water spray quenched
CWQ - Cold water quench
BWQ - Boiling water quench
A - Cooled in air
(c) 1x1 quarter sections from 2 in dia. extrusions
(d) Longitudinal processed as 1x1 quadrants, approx. cooling rate 350°F/sec. Transverse processed as 5/16" thick slices, approx. cooling rate 1500°F/sec.
(e) Failed before reaching 0.2% offset
(f) Classified powder - Fine fraction
(g) Specimen shattered - Not determined
(h) Approximate cooling rate from 750° to 550°F

Table VIII

TENSILE PROPERTIES OF APM EXTRUSIONS AT CRYOGENIC AND ELEVATED TEMPERATURES

Alloy No.	S-No.	Heat Treat No.(a)	-112°F T.S. ksi	-112°F Y.S. ksi	-112°F El. % in 4D	-18°F T.S. ksi	-18°F Y.S. ksi	-18°F El. % in 4D	75% (Room Temp.) T.S. ksi	75% (Room Temp.) Y.S. ksi	75% (Room Temp.) El. % in 4D	1/2 hr. at 212°F T.S. ksi	1/2 hr. at 212°F Y.S. ksi	1/2 hr. at 212°F El. % in 4D	1/2 hr. at 400°F T.S. ksi	1/2 hr. at 400°F Y.S. ksi	1/2 hr. at 400°F El. % in 4D
34	283442	2	-	-	-	-	-	-	109.8	109.1	0.0	96.8	(b)	(c)	48.4	40.4	17.7
			-	-	-	-	-	-	103.5	(b)	0.0	93.5	(b)	(c)	47.7	36.7	14.9
	AVG		-	-	-	-	-	-	106.7	-	0.0	95.4	-	-	48.1	38.6	16.3
38	283452	2	-	-	-	-	-	-	115.6	111.3	(c)	100.4	97.0	1.4	46.4	39.8	21.1
			-	-	-	-	-	-	112.9	112.2	0.0	104.5	100.2	1.4	45.6	41.8	22.9
	AVG		-	-	-	-	-	-	114.6	111.8	-	102.5	98.6	1.4	46.0	40.8	22.0
39	283462	2	-	-	-	-	-	-	112.2	112.2	0.0	105.7	102.8	1.0	56.4	51.9	9.7
			-	-	-	-	-	-	113.4	111.2	0.0	108.6	104.0	1.0	55.7	51.4	19.4
	AVG		-	-	-	-	-	-	112.8	111.7	0.0	107.2	103.4	1.0	56.1	51.7	14.6
		3	-	-	-	-	-	-	107.0	104.7	0.0	99.9	95.0	2.0	50.8	48.0	22.3
49	283472	2	-	-	-	-	-		108.2	(b)	0.0	103.3	102.2	0.5	55.9	52.1	10.7
			-	-	-	-	-	-	103.5	(b)	0.0	107.3	106.1	0.5	55.6	52.6	13.1
	AVG								105.9	-	0.0	105.3	104.2	0.5	55.8	52.4	11.9
		3	-	-	-	-	-	-	111.0	107.7	0.6	99.5	97.9	1.6	51.6	47.7	10.9
50	283483	2	-	-	-	-	-	-	114.7	112.7	0.0	106.4	104.0	2.0	54.2	52.1	12.0
			-	-	-	-	-	-	114.0	111.1	0.6	104.7	101.5	1.0	54.7	51.8	15.4
	AVG		-	-	-	-	-	-	114.4	111.9	0.3	105.6	102.8	1.5	54.5	52.0	13.7
52	283493	2	-	-	-	-	-	-	116.2	112.5	2.3	105.1	102.1	3.0	48.5	47.7	23.4
			-	-	-	-	-	-	114.0	109.6	1.5	103.5	100.6	3.0	48.2	45.6	19.4
	AVG		-	-	-	-	-	-	115.1	111.1	1.9	104.3	101.4	3.0	48.4	46.7	21.4
52	283494	2	124.6	122.2	2.0	120.2	119.2	2.0	116.6	112.2	1.4	109.8	103.7	4.0	56.3	52.8	16.0
			126.2	126.2	1.0	119.8	117.2	2.0	(e)81.7	(d)(e)	0.0(e)	106.6	101.2	5.0	53.2	50.9	19.0
	AVG		125.4	124.2	1.5	120.0	118.2	2.0	116.6	112.2	1.4	108.2	102.4	4.5	54.8	51.8	17.5
61	283759	2	-	-	-	-	-	-	114.1	110.1	2.2	105.5	102.9	3.0	52.4	50.6	18.3
			-	-	-	-	-	-	115.7	111.9	3.5	104.7	102.3	4.0	51.3	50.8	21.7
	AVG		-	-	-	-	-	-	114.9	111.0	2.9	105.1	102.6	3.5	51.9	50.7	20.0
62	307310	2	125.2	124.2	2.0	121.2	119.2	2.0	116.2	113.7	2.1	106.1	101.8	7.0	53.1	49.9	22.0
			124.6	124.2	2.0	122.2	120.2	2.0	117.5	(d)	(c)	107.4	103.2	5.0	53.1	51.5	23.0
	AVG		124.9	124.2	2.0	121.7	119.7	2.0	116.8	113.7	2.1	106.8	102.5	6.0	53.1	50.7	22.5
64	307312	2	123.2	122.2	(c)	119.2	117.1	2.0	116.2	(d)	1.9	106.0	101.4	5.0	51.0	47.5	26.0
			122.2	122.2	2.0	118.1	116.1	3.0	118.0	113.1	1.1	106.9	101.9	8.0	50.6	46.0	28.0
	AVG		122.7	122.2	2.0	118.6	116.6	2.5	117.1	113.1	1.5	106.4	101.6	6.5	50.8	46.8	27.0
71	307319	2	123.6	123.2	3.0	117.1	116.1	4.0	113.6	(d)	3.7	103.6	99.2	10.0	48.0	46.1	26.0
			125.2	125.2	2.0	118.1	116.1	3.0	115.3	112.0	3.6	103.7	100.4	11.0	47.2	44.2	24.0
	AVG		124.4	124.2	2.5	117.6	116.1	3.5	114.4	112.0	3.6	103.6	99.8	10.5	47.6	45.2	25.0
7075-T6 (Extrusions)			97.0	91.0	8.0	93.0	86.0	9.0	90.0	83.0	10.0	83.0	78.0	15.0	42.0	40.0	18.0
X2020-T6			88.0	81.0	5.0	86.0	79.0	6.0	84.0	77.0	7.0	77.0	72.0	9.0	57.0	54.0	8.0

(a) #2 S.H.T. 1/2 hr. 920°F, CWQ, 96 hrs. at 225°F.
#3 S.H.T. 2 hrs. 860°F, CWQ, 96 hrs. at 225°F.

(b) Failed before reaching 0.2% offset.

(c) Not obtained - specimen shattered.

(d) Not obtained.

(e) Not included in average.

Table IX

THE EFFECT OF TIME AT ELEVATED TEMPERATURE ON LONGITUDINAL TENSILE PROPERTIES OF ALLOY 52

S. No.	Heat Treatment No. (a)	Time at Temp.	212°F T.S. ksi	212°F Y.S. ksi	212°F El. % in 4D	400°F T.S. ksi	400°F Y.S. ksi	400°F El. % in 4D
283493 (b)	2	1/2	105.1	102.1	3.0	48.5	47.7	23.4
			103.5	100.6	3.0	48.2	45.6	19.4
283494 (c)	2	1/2	109.8	103.7	4.0	56.3	52.8	16.0
			106.6	101.2	5.0	53.2	50.9	19.0
AVG			106.2	101.9	3.8	51.6	49.2	19.4
283497 (d)	2	1/2	106.4	103.9	1.14	47.9	43.8	22.1
283497 (d)	2	100	106.1	102.9	5.0 (f)	25.3	22.9	49.3
283497 (d)	1	1/2	97.2	93.9	7.9 (e)	46.2	41.5	22.9
283497 (d)	1	100	97.4	92.9	1.4	23.7	22.1	57.1
7075-T6		1/2	83.0	78.0	15.0	42.0	40.0	18.0
"		100	84.0	79.0	14.0	22.0	20.0	35.0
X2020-T6		1/2	77.0	72.0	9.0	57.0	54.0	8.0
"		100	78.0	73.0	9.0	38.0	34.0	15.0

(a) Heat Treatment #1 - SHT 2 hrs. at 860°F, CWQ, Aged 24 hrs. at 250°F.
Heat Treatment #2 - SHT 1/2 hr. at 920°F, CWQ, Aged 96 hrs. at 225°F.
(b) Compact preheat temperature 1000°F, 81% dense green compact.
(c) Compact preheat temperature 1050°F, 81% dense green compact.
(d) Compact preheat temperature 950°F, 74% dense green compact.
(e) Specimen fractured in three places.
(f) Reduced section splintered longitudinally.

Table X

IMPACT AND TEAR PROPERTIES OF APM MATERIAL

Alloy Number	Sample Number	H.T. No. (a)	Izod Impact Energy At Failure ft-lb (b)	Tear Test Propagation in.lb/in.^{2} Long.	Unit Energy (c) Trans.
52	283492	2	1.0	-	-
	307454	1	-	0	0
	307455	1	-	0	0
	307454	2	-	0	0
	307455	2	-	0	0
62	307321	1	1.1	0	0
	307321	2	-	0	0
64	307323	1	1.1	0	0
	307323	2	-	0	0
71	307330	1	1.3	0	0
	307330	2	-	0	0
7178-T6	Typical	-	-	140 (d)	130 (d)
7075-T6 (e)	Typical	-	4.5	290 (d)	220 (d)
195-T6	Typical	-	2	-	-
356-T6	Typical	-	1	75 (e)	-

(a) H.T. #1, SHT 2 hrs. at 860°F, CWQ, Aged 24 hrs. at 250°F.
H.T. #2, SHT 1/2 hr. at 9[illegible]0°F, CWQ, Aged 96 hrs. at 225°F.

(b) Obtained from 2 in. dia. extrusions.

(c) .10 in. Thick rolled stock from 1" x 4-1/4" extrusions of alloys covered in this contract.

(d) Results of tear tests from 0.063 in. Al sheet.

(e) Unpublished data.

Table XI

COMPARISON OF TEAR TEST PROPERTIES AFTER STEP AGING

Alloy No.	S. No.	Heat Treatment (b)	Test Specimen Thickness in.	Y.S. ksi	Tear Strength ksi	Tear/Yield Ratio	Unit Propagation Energy in-lb/in^2	Product Tested
38	283451	#1	0.1000	108.2	20.8	0.19	65	Extrusion
	283451	#1A	0.1000	69.9	28.4	0.41	95	Extrusion
52	283490	#1	0.1002	105.6	29.1	0.28	100	Extrusion
	283490	#1B	0.0987	69.6	32.4	0.47	115	Extrusion
71	283387	#1C	0.1006	88.1	63.2	0.72	230	Extrusion
	293387	#1D	0.1010	71.1	44.4	0.62	120	Extrusion
7075	(c)	-T6	0.1000	74.7	65.0	0.87	300	Extrusion
7075	(c)	-T6	0.063	75.1	78.1	1.04	290	Sheet
7178	(c)	-T6	0.063	81.3	61.8	0.76	140	Sheet

Note: (a) Kahn Type Tear Test, Ref. 4

(b) #1 SHT 2 hours at 860°F, CWQ, Aged 24 Hours at 250°F.

1A Age #2 18 Hrs. at 330°F
1B Age #2 24 Hrs. at 330°F
1C Age #2 3 Hrs. at 330°F
1D Age #2 20 Hrs. at 330°F

-T6 similar to #1 except SHT---870°F

(c) Specific test values from available data. Not to be considered as typical.

Table XII

ELECTRICAL CONDUCTIVITY DATA

Alloy	S. No.	SHT(f) t	SHT(f) T(a)	Age (a) t	Age (a) T	Age (a) t	Age (a) T	TS ksi	YS ksi	El, %	Electrical Conductivity % IACS (c)
38	283451	2	860	24	250	--	---	112	108	1.2	< 25
38	283453	2	860	24	250	--	---	108	105	0.8	< 25
38	283453	2	860	24	250	2	330	97	93	2.1	25.9
38	283453	2	860	24	250	4	330	91	84	3.0	26.7
38	283453	2	860	24	250	8	330	87	80	3.0	27.6
38	283453	2	860	24	250	16	330	82	72	4.0	28.0
38	283451	2	860	24	250	18	330	82	70	4.0	29.3
38	283453	2	860	24	250	32	330	76	64	5.0	29.1
38	283453	2	860	24	250	48	330	73	61	5.5	29.6
38	283453	2	860	24	250	1	350	93	87	2.5	26.3
38	283453	2	860	24	250	2	350	88	82	2.5	27.3
38	283453	2	860	24	250	4	350	84	75	4.0	27.7
38	283453	2	860	24	250	8	350	79	68	4.5	28.5
38	283453	2	860	24	250	12	350	76	64	5.5	28.9
39	283460	2	860	24	250	--	---	107	104	1.3	< 25
39	283460	2	860	24	250	16	330	81	71	1.8	27.8
39	283460	2	860	24	250	32	330	73	62	2.3	28.7
39	283460	2	860	24	250	48	330	74	61	4.0	29.2
39	283460	2	860	24	250	4	350	82	75	1.8	27.3
39	283460	2	860	24	250	8	350	79	68	3.0	28.2
39	283460	2	860	24	250	12	350	77	65	3.5	28.7
49	283471	2	860	24	250	--	---	107	104	1.0	< 25
49	283471	2	860	24	250	16	330	81	77	2.1	28.2
49	283471	2	860	24	250	32	330	75	67	3.0	29.3
49	283471	2	860	24	250	48	330	72	63	3.0	29.8
49	283471	2	860	24	250	4	350	84	78	1.5	27.4
49	283471	2	860	24	250	8	350	71	66	1.4	28.7
49	283471	2	860	24	250	12	350	71	66	2.4	29.3
50	283480	2	860	24	250	--	---	100	96	1.5	< 25
50	283480	2	860	24	250	16	330	85	77	1.6	27.9
50	283480	2	860	24	250	32	330	78	70	2.4	29.0
50	283480	2	860	24	250	48	330	74	66	2.0	29.2
50	283480	2	860	24	250	4	350	85	79	1.9	27.4
50	283480	2	860	24	250	8	350	80	73	2.4	28.2
50	283480	2	860	24	250	12	350	78	69	2.4	28.8
52	307454(b)	2	860	24	250	--	---	100	95	2	28.6
52	307455(b)	2	860	24	250	--	---	103	98	2	28.2
52	283490	2	860	24	250	--	---	109	106	2.9	28.9
52	283496	2	860	24	250	--	---	107	105	2.6	28.2
52	283496	2	860	24	250	2	330	95	93	1.9	31.5
52	283496	2	860	24	250	4	330	94	90	4.2	32.5
52	283496	2	860	24	250	8	330	91	84	6.5	33.8
52	283496	2	860	24	250	16	330	84	76	6.5	34.7
52	283490	2	860	24	250	24	330	79	70	6.0	36.2
52	283496	2	860	24	250	32	330	77	68	6.0	36.0
52	283496	2	860	24	250	48	330	73	62	7.0	36.7
52	283496	2	860	24	250	1	350	95	90	5.0	32.1
52	283496	2	860	24	250	2	350	91	85	5.0	33.1
52	283496	2	860	24	250	4	350	85	77	6.5	34.1
52	283496	2	860	24	250	8	350	80	70	8.0	35.1
52	283496	2	860	24	250	12	350	77	66	8.0	36.1
52	307454(b)	0.5	920	96	225	--	---	96	---	---	27.6
52	307455(b)	0.5	920	96	225	--	---	102	97	2	28.6
62	307321(b)	2	860	24	250	--	---	104	97	3	28.4
62	307321(b)	0.5	920	96	225	--	---	79	---	---	27.3
64	307323(b)	2	860	24	250	--	---	96	90	2	27.4
64	307323(b)	0.5	920	96	225	--	---	83	---	---	26.3
71	307330(b)	2	860	24	250	--	---	100	94	4	29.2
71	293387	2	860	24	250	--	---	108	103	4.5	31.0
71	293387	2	860	24	250	2	300	103	100	5.2	32.1
71	293387	2	860	24	250	4	300	101	98	5.8	32.5
71	293387	2	860	24	250	8	300	99	95	6.5	33.5
71	293387	2	860	24	250	24	300	91	86	7.8	35.4
71	293387	2	860	24	250	48	300	86	79	9.2	36.8
71	293387	2	860	24	250	2	330	97	93	6.0	33.6
71	293387	2	860	24	250	4	330	93	88	8.0	34.0
71	293387	2	860	24	250	8	330	87	81	9.2	36.3
71	293387	2	860	24	250	16	330	82	74	9.5	37.4
71	293387	2	860	24	250	32	330	76	66	11.2	38.7
71	293387	2	860	24	250	48	330	73	62	11.5	39.2
71	307330(b)	0.5	920	96	225	--	---	98	93	3	29.0
7075-T651 (d)(e)		--	---	--	---	--	---	88	80	11	32.0
7178-T651 (d)(e)		--	---	--	---	--	---	92	84	8	32.5

NOTE:
(a) t - time in hours, T - temperature in °F.
(b) Data from 1" x 4-1/4" extrusions rolled to sheet. All other tests - 2" diameter.
(c) Reading taken midway between edge and center.
(d) Typicals from R. R. Sons 3/23/65, 2 to 3 inch diameter extrusions.
(e) Typicals from C. F. Babilon 4/5/66, plate and rolled rod.
(f) Quenched in cold water immediately after SHT

Table XIII

EFFECT OF DISPERSOIDS ON TENSILE PROPERTIES

REF. TABLE II HEAT TREATMENT NO. 1

Alloy	Composition: Dispersoids Wt. %		Total	Zn	Mg	Cu	Longitudinal: T.S. ksi	Y.S. ksi	EL. % in 4D
90	1.1 Fe, 1.0 Ni,	(0.9 Ni/Fe)	2.1	7.5	2.4	1.0	99	93	5.4
87	2.2 Fe, 2.3 Ni,	(1.0 Ni/Fe)	4.5	7.6	2.5	1.1	104	99	1.4
86	4.0 Fe, 2.1 Ni,	(0.5 Ni/Fe)	6.1	7.6	2.6	1.1	107	101	1.0
85	2.2 Fe, 4.8 Ni,	(2.2 Ni/Fe)	7.0	7.6	2.6	1.1	88	84	1.5
34	3.9 Fe, 5.3 Ni,	(1.4 Ni/Fe)	9.2	7.8	2.5	1.1	106	105	0.7
19	--------------		0	7.5	3.0	1.7	101	95	7.2
9	0.5 Cr, 0.4 V, 0.4 Zr, 0.4 Ti		1.7	7.9	3.5	1.6	99	94	2.5
11	1.4 Co, 1.6 Mo, 0.5 W,		3.5	7.6	3.5	1.5	98	95	0.7
8	1.6 Mn, 1.6 Fe, 1.4 Ni,		4.3	7.9	3.5	1.5	106	102	1.4
7	2.5 Fe, 2.0 Ni,		4.5	7.9	3.4	1.5	106	102	1.4
12	0.6 Mn, 0.5 Fe, 0.6 Ni, 0.5 Cr, 0.4 Ti, 0.4 V, 0.6 Zr, 0.5 Co, 0.5 Mo, 0.5 W		4.8	7.8	3.5	1.6	98	95	0.7
10	2.1 Cr, 0.9 Ti, 1.7 V, 0.9 Zr,		5.6	7.9	3.5	1.5	84	84	0.0
62	0.8 Co,		0.8	10.0	4.0	0.9	107	103	2.6
52	1.4 Co,		1.4	9.7	4.1	0.8	106	103	1.8
63	2.3 Co,		2.3	10.1	4.0	0.9	104	101	0.6
68	1.5 Co,		1.5	9.9	3.9	1.5	106	101	1.6
57	2.0 Mn, 1.2 Fe, 2.6 Ni, 0.1 Ti,		5.5	9.6	4.0	1.9	106	164	0.4
28	--------------		0	9.8	3.8	2.3	102	99	2.5
58	2.2 Mn, 1.4 Fe, 3.2 Ni,		6.5	10.0	4.1	2.5	104	--	0.0
46	0.6 Mn, 1.1 Cr, 1.0 Zr,		2.4	11.4	4.6	0.9	100	96	0.8
45	3.0 Mn, 0.8 Cr, 0.5 Zr,		4.0	11.7	4.6	0.9	101	100	0.4

Table XIV

COMPARISON OF ALLOY TYPES WITH RESPECT TO ELONGATION

REF: TABLE II, HEAT TREATMENT NO. 1

Y.S./ρ	Elongation, % (Alloy No.) Precipitation Alloys	Dispersion & Precipitation Alloys
1.03×10^6	3.2 (61)	---
1.02	---	3.1 (71)
1.02	---	0 (38)
1.01	2.1 (1)	1.8 (33)
1.01	---	1.6 (69)
1.01	---	1.5 (65)
1.00	---	2.6 (62)
1.00	---	2.2 (66)
1.00	---	1.9 (67)
0.99	1.1 (3)	1.9 (60)
0.99	---	1.4 (36)
0.99	---	1.4 (99)
0.99	---	0.8 (39)
0.99	---	0.8 (70)
0.99	---	0 (35)
0.98	2.9 (2)	1.8 (52)
0.97	1.8 (4)	2.0 (64)
0.97	1.4 (29)	1.6 (68)
0.97	---	1.4 (8)
0.97	---	1.1 (50)
0.97	---	0.9 (51)
0.97	---	0.6 (63)
0.96	---	1.4 (5)
0.96	---	1.4 (7)
0.96	---	0.7 (34)
0.96	---	0.7 (40)
0.96	---	0.3 (54)
0.95	2.5 (28)	1.2 (43)
0.95	---	0.7 (48)
0.95	---	0.7 (55)
0.94	7.2 (19)	1.4 (87)
0.94	4.0 (6)	1.0 (86)
0.94	---	0.9 (56)
0.94	---	0.0 (57)
0.93	4.0 (20)	1.1 (13)
0.93	2.9 (27)	0.7 (14)

TABLE XV

EFFECT OF COMPACT PREHEAT TIME AND TEMPERATURE LONGITUDINAL TENSILE PROPERTIES (2)

ALLOY (1)	S. No.	COMPACT PREHEAT Time Hr.	COMPACT PREHEAT TEMP. °F.	HEAT TREATMENT #1 T.S. ksi	HEAT TREATMENT #1 Y.S. ksi	HEAT TREATMENT #1 EL %	HEAT TREATMENT #2 T.S. ksi	HEAT TREATMENT #2 Y.S. ksi	HEAT TREATMENT #2 EL (%)
36	278038	1.25	750	99.9	97.2	1.2	56.4(d)	(c)	(b)
	278042	21.5	750	103.4	100.4	1.4	113.6	113.3	(b)
	277644	.25	850 (a)	102.1	97.4	1.9	110.5	107.9	(b)
	277645	.75	850 (a)	105.9	102.1	1.4	118.5	115.9	1.1
	277424	12	900	109.4	106.9	1.4	-	-	-
38	278039	2.25	750	106.5	105.0	0.7	117.7	117.2	(b)
	278043	22.25	750	107.9	104.4	1.6	119.5	118.4	(b)
	277646	1.5	850 (a)	111.1	108.4	1.0	119.6	117.0	1.2
	277647	4	850 (a)	109.9	106.9	1.8	117.4	115.7	(b)
	277426	12	900	112.3	109.7	(b)	-	-	-

Notes: (1)

ALLOY	Zn	Mg	Cu	Mn	Fe	Ni
36	10.7	3.8	2.0	1.7	--	--
38	8.4	3.6	-	1.0	0.8	2.8

(2) Each result represents one test

(3) Thermal Treatments:

#1 Pieces 2" dia. x 6.5" long from front of extrusion solution heat treated 2 hrs at 860°F, CWQ, aged immediately 24 hrs. at 250°F (H.T. #1)

#2 Quadrants of 2" dia. rod x 4.75" long were solution heat treated .5 hr at 920°F, CWQ, and aged immediately 96 hrs at 225°F (H.T. #2)

(4)
(a) Compact extruded without hot pressing against a blind die
(b) Not obtained. Specimen shattered
(c) Not obtained. Specimen failed before reaching 0.2% offset
(d) Melting occurred during solution heat treatment

Table XVI

EFFECT OF DIE QUENCHING ON TENSILE PROPERTIES

S. No.	Alloy	Composition % Zn	Mg	Cu	Mn	Fe	Ni	Compact Preheat Hr	°F	Quench	Thermal Treat-ment (a)	Longitudinal T.S. ksi	Y.S. ksi	El. in 4D %
278180	36	10.7	3.8	2.0	1.7	---	---	.75	920	Die	A	100.3	95.2	1.0
277424	36	10.7	3.8	2.0	1.7	---	---	12.	900	CWQ	B	109.4	106.9	1.4
278181(b)	38	8.4	3.6	---	1.0	.8	2.8	1.75	920	Die	A	102.8	99.5	0.7
277426	38	8.4	3.6	---	1.0	0.8	2.8	12.	900	CWQ	B	112.3	109.7	(c)

NOTE: Each result represents one tensile test

(a) Thermal treatment to -T6 temper as follows:
  A. Pieces from middle of die quenched 2" dia. extrusion was aged 24 hrs. at 250°F
  B. Pieces from front of 2" dia. extrusion was solution heat treated 2 hrs. at 860°F, CWQ, and aged 24 hrs. at 250°F

(b) Extruded with 7075 alloy leader

(c) Not obtained. Specimen shattered

Table XVII

EFFECT OF POWDER SIZE ON LONGITUDINAL TENSILE PROPERTIES

Alloy	S. No.	Compact Preheat		Powder	Heat Treatment #1			Heat Treatment #2		
		Time Hr.	Temp. °F	Size (e)	T.S. ksi	Y.S. ksi	El %	T.S. ksi	Y.S. ksi	El %
36	277938	3.5	850 (a)	14	95.4	95.2	0.5	108.1	106.3	(c)
	277939	2.5	850 (a)	5	94.5	92.2	0.6	110.4	109.4	(c)
38	277936	2.75	850 (a)	13	101.5	100.5	0.6	113.1	112.6	(c)
	277937	1.75	850 (a)	6	100.5	97.7	1.1	109.1	105.2	(c)
59	277934	2.00	850 (a)	15	90.9	(b)	0.4	91.9	(b)	(c)
	277935	1.00	850 (a)	6	90.4	(b)	0.4	107.4	(b)	(c)

Notes: (1) Composition:

Alloy	Zn	Mg	Cu	Mn	Fe	Ni
36	10.6	4.4	2.0	1.7	-	-
38	8.2	3.3	-	1.1	1.1	3.0
59	10.2	3.9	1.6	1.6	1.0	4.1

(2) Each result represents one tensile test.

(3) a. Compact extruded without hot pressing against blind die.
b. Not obtained. Specimen failed before reaching 0.2% offset.
c. Not obtained. Specimen shattered.
d. Thermal treatment as follows:
#1 Pieces 2" dia. x 6.5" long from front of extrusions were solution heat treated 2 hrs at 860°F, CWQ, and aged immediately 24 hrs at 250°F.
#2 Quarter sections of 2" dia. rod x 4.75" long were solution heat treated .5 hr at 920°F, CWQ, and aged immediately 96 hrs at 225°F.

e. Microns, by Fisher SSS.

Table XVIII

EFFECT OF POWDER SIZE ON TRANSVERSE TENSILE PROPERTIES

Alloy	S. No.	Compact Preheat Time Hr.	Compact Preheat Temp. °F.	Powder Size (d)	2" Dia. x 6.5" Long (c) T.S. ksi	2" Dia. x 6.5" Long (c) Y.S. ksi	2" Dia. x 6.5" Long (c) El. %	2" Dia. x .31" Long (c) T.S. ksi	2" Dia. x .31" Long (c) Y.S. ksi	2" Dia. x .31" Long (c) El. %
36	277938	3.5	850 (a)	14	70.5	(b)	0.0	64.0	(b)	0
	277939	2.5	850 (a)	5	80.4	(b)	0.2	88.6	(b)	0
38	277936	2.75	850 (a)	13	86.2	(b)	0.0	92.3	(b)	0
	277937	1.75	850 (a)	6	93.1	(b)	0.0	96.4	(b)	0
59	277934	2.00	850 (a)	15	64.6	(b)	0.0	61.2	(b)	0
	277935	1.00	850 (a)	6	85.0	(b)	0.0	91.5	(b)	0

Notes: (1) See Section II, Table VIII for details

(2) Composition:

Alloy	Zn	Mg	Cu	Mn	Fe	Ni
36	10.6	4.4	2.0	1.7	-	-
38	8.2	3.3	-	1.1	1.1	3.0
59	10.2	3.9	1.6	1.6	1.0	4.1

(3) (a) Compact extruded without pressing against blind die

(b) Failed before reaching 0.2% offset

(c) Specimens of indicated size solution heat-treated 2 hrs @ 860°F, CWQ, aged immediately for 24 hrs at 250°F.

(d) Microns, by Fisher SSS.

Table XIX

EFFECT OF HEAT TREATMENT AND AGING ON TENSILE PROPERTIES OF EXTRUSIONS (b)

Longitudinal Properties	Alloy 52 S-No. 283494 Front	Back	Avg.	Alloy 62 S-No. 307310 Front	Back	Avg.	Alloy 64 S-No. 307312 Front	Back	Avg.	Alloy 71 S-No. 307319 Front	Back	Avg.
Heat Treatment #2 S.H.T. 1/2 hr at 920°F, CWQ, Aged 96 hrs at 225°F												
T.S., ksi	116.6	81.7(c)	116.6	116.8(g)	-	116.8	117.1(g)	-	117.1	114.4(g)	-	114.4
Y.S., ksi	112.2	(a)	112.2	113.7	-	113.7	113.1	-	113.1	112.0	-	112.0
El. % In 4D	1.4	0.0(c)	1.4	2.1	-	2.1	1.5(g)	-	1.5	3.6(g)	-	3.6
Y.S./Density, x 10^6 in.	1.072	-	1.072	1.097	-	1.097	1.090	-	1.090	1.087	-	1.087
Heat Treatment #3 S.H.T. 2 hrs at 860°F, CWQ, Aged 96 hrs at 225°F												
T.S., ksi	-	-	-	112.2(g)	-	112.2	109.6(g)	-	109.6	114.7(g)	-	114.7
Y.S., ksi	-	-	-	110.3	-	110.3	107.4	-	107.4	111.4	-	111.4
El. % In 4D	-	-	-	1.8(g)	-	1.8	1.1(g)	-	1.1	2.4(g)	-	2.4
Y.S./Density, x 10^6 in.	-	-	-	1.065	-	1.065	1.035	-	1.035	1.082	-	1.082
Heat Treatment #M S.H.T. 2 hrs at 830°F, CWQ, Aged 96 hrs at 225°F (f)												
T.S., ksi	103.2	107.1	105.2	91.6(c)	107.1	107.1	106.2	105.9	106.0	107.0	106.9	107.0
Y.S., ksi	103.2	103.7	103.4	89.6(c)	104.9	104.9	103.5	103.2	103.4	105.5	105.4	105.4
El. % In 4D	0.9	2.9	1.9	1.4(bc)	2.9	2.9	2.1	4.0	3.0	4.9	4.3	4.6
Y.S./Density, x 10^6 in.	0.986	0.990	0.988	0.865(c)	1.012	1.012	0.997	0.994	0.996	1.024	1.023	1.023
Heat Treatment #K S.H.T. 2 hrs at 830°F. CWQ, Aged 48 hrs at 250°F												
T.S., ksi	105.0	103.4	104.2	88.9(c)	105.2	105.2	105.2	88.1(c)	105.2	105.7	102.7	104.2
Y.S., ksi	102.5	101.0	101.8	(a,c)	103.2	103.2	102.5	(a,c)	102.5	104.7	102.7	103.7
El. % In 4D	3.2	2.8	3.0	(b,c)	4.1	4.1	3.0	(b,c)	3.0	3.7	1.3	2.5
Y.S./Density x 10^6 in.	0.979	0.965	0.972	-	0.996	0.996	0.987	-	0.987	1.016	0.997	1.007
Heat Treatment #L S.H.T. 2 hrs at 830°F, CWQ, Aged 24 hrs at 250°F												
T.S., ksi	103.2	102.7	103.0	103.2	105.4	104.3	102.4	102.7	102.6	103.9	106.4	105.2
Y.S., ksi	101.0	100.0	100.5	100.5	102.9	101.7	99.8	99.5	99.6	102.0	105.0	103.5
El., % In 4D	3.2	2.7	3.0	3.0	3.3	3.2	3.8	2.9	3.4	5.3	4.8	5.0
Y.S./Density, x 10^6 in.	0.965	0.955	0.960	0.970	0.993	0.982	0.961	0.958	0.960	0.990	1.019	1.005
Heat Treatment #P S.H.T. 2 hrs at 860°F. CWQ, Aged 6 hrs at 250 + 8 hrs at 330°F												
T.S., ksi	91.8	90.5	91.2	91.3	91.8	91.6	91.7	91.8	91.8	89.2	90.3	89.8
Y.S., ksi	88.1	87.1	87.6	86.6	97.1	86.8	86.5	86.9	86.7	84.6	85.6	85.1
El. % In 4D	5.4	5.8	5.6	7.7	6.2	7.0	6.6	7.0	6.8	8.6	9.1	8.8
Y.S./Density x 10^6 in.	0.841	0.832	0.837	0.836	0.841	0.838	0.833	0.837	0.835	0.821	0.831	0.826
Heat Treatment #N S.H.T. 2 hrs at 860°F. CWQ, Aged 6 hrs at 225°F + 8 hrs at 350°F												
T.S., ksi	33.2	84.2	83.7	83.3	84.7	84.0	84.1	85.1	84.6	83.4	82.4	82.9
Y.S., ksi	76.7	78.2	77.4	76.5	78.0	77.2	76.2	77.2	76.7	76.7	75.2	76.0
El., % In 4D	6.6	7.1	6.8	8.8	9.3	9.0	8.0	7.3	7.6	10.5	11.6	11.0
Y.S./Density, x 10^6 in.	0.732	0.747	0.739	0.738	0.753	0.745	0.734	0.744	0.739	0.745	0.730	0.738

(a) Failed before reaching 0.2% offset.
(b) Failed through gage mark.
(c) Premature failures - not included in average.
(d) Average Of 3 values.
(e) Specimen shattered.
(f) Letters assigned non standard heat treatments for ease in reference.
(g) Average 2 values.
(h) Heat treated as quadrants.

TABLE XX

TENSILE PROPERTIES OF ALLOYS CONTAINING DECREASING AMOUNTS OF IRON AND NICKEL AND GIVEN VARYING AGING TREATMENTS

Alloy No. (a)		S. No.	Heat Treatment (h) SHT t	SHT T	Quench	AGE t	AGE T	Longitudinal (b) TS ksi	YS ksi	El. % In 4D	YS/Density x10⁶ In	Transverse (b) TS ksi	YS ksi	El. % In 4D
34		(c)	2	860	CWQ	24	250	106.6(d)	106.5 (d)	0.7 (d)	0.997	103.1 (d)	90.7 (d)	0.6 (d)
								97.1(e)	(f) (e)	0.7 (e)	--	84.1 (e)	(f)(e)	(g)(e)
	Avg							103.7(c)	103.6 (c)	0.7 (c)	--	94.6 (c)	90.5 (c)	--
87		293196	2	860	CWQ	24	250	106.6 (d)	99.3 (d)	5.1 (d)	0.938 (d)	97.6 (d)	92.2 (d)	1.5 (d)
								103.7 (e)	98.8 (e)	1.0 (e)	0.934 (e)	87.9 (e)	86.9 (e)	0.7 (e)
	Avg							104.8 (c)	99.1 (c)	2.6 (c)	0.937 (c)	92.5 (c)	89.5 (c)	1.1 (c)
90		294014	2	860	CWQ	24	250	98.8	92.4	5.4	0.885	87.6	80.5	2.4
								91.1	93.6	5.4	0.897	86.5	80.7	2.3
	Avg							99.0	93.0	5.4	0.891	87.0	80.6	2.4
79		293188	2	860	CWQ	24	250	97.2 (d)	88.8 (d)	5.5 (d)	0.856 (d)	90.2 (d)	81.6 (d)	4.1 (d)
								96.3 (e)	87.3 (e)	2.7 (e)	0.842 (e)	84.1 (e)	75.4 (e)	3.4 (e)
	Avg							96.9 (c)	88.0 (c)	3.7 (e)	0.849 (c)	86.7 (c)	77.5 (e)	3.8 (c)
34		(c)	2	860	CWQ	6/250+ 8/330		88.7 (i)	83.2 (i)	0.7 (i)	0.764 (i)	91.6 (d)	88.5 (d)	1.3 (d)
								87.9 (i)	82.2 (i)	0.7 (i)	0.755 (i)	79.3 (e)	77.6 (e)	0.2 (e)
	Avg							88.3 (i)	82.7 (i)	0.7 (i)	0.759 (i)	84.5 (c)	81.4 (c)	0.8 (c)
87		293196	2	860	CWQ	6/250+ 8/330		90.1	80.7	7.0	0.763	83.9	75.6	2.7
								--	--	--	--	84.0	76.0	2.9
	Avg							90.1	80.7	7.0	0.763	84.0	75.8	2.8
90		294014	2	860	CWQ	6/250+ 8/330		84.4	77.9	8.6	0.746	79.5	71.3	5.8
								84.4	78.1	7.9	0.748	75.2	70.9	2.9
	A							84.4	78.0	8.2	0.747	77.4	71.1	4.4
79		293188	2	860	CWQ	6/250+8/330		86.4	77.0	7.5	0.743	79.3	71.1	3.5
								--	--	--	--	78.7	70.1	3.4
	Avg							86.4	77.0	7.5	0.743	79.0	70.6	3.4
34		283440	2	860	CWQ	16	330	82.6 (i)	76.2 (i)	0.7 (i)	0.700 (i)	86.2 (d)	80.3 (d)	1.4 (d)
								83.0 (i)	75.7 (i)	0.7 (i)	0.695 (i)	76.5 (e)	71.1 (e)	0.6 (e)
	Avg							82.8 (i)	76.0 (i)	0.7 (i)	0.698 (i)	81.0 (c)	75.8 (c)	1.0 (c)
87		292196	2	860	CWQ	16	330	85.7	74.6	7.0	0.705	77.5	70.3	2.7
								--	--	--	--	79.9	70.1	3.9
	Avg							85.7	74.6	7.0	0.705	78.7	70.2	3.3
90		294014	2	860	CWQ	16	330	77.7	68.7	9.3	0.658	72.3	65.0	4.0
								78.2	70.0	10.0	0.670	73.2	65.4	5.3
	Avg							78.0	69.4	9.6	0.665	72.8	65.2	4.6
79		293188	2	860	CWQ	16	330	80.2	68.5	9.0	0.661	74.4	64.5	4.5
								--	--	--	--	75.8	64.5	6.4
	Avg							80.2	68.5	9.0	0.661	75.1	64.5	5.4
34		(c)	2	860	CWQ	46	315	79.1 (i)	73.1 (i)	0.7 (i)	0.671(i)	83.4 (d)	76.8 (d)	2.2 (d)
								82.1 (i)	73.0 (i)	0.7 (i)	0.670(i)	73.0 (e)	69.1 (e)	0.5 (e)
	Avg							80.6 (i)	73.0 (i)	0.7 (i)	0.670(i)	77.9 (c)	72.5 (c)	1.2 (c)
87		293196	2	860	CWQ	48	315	82.9	69.5	10.0	0.657	77.6	65.9	3.8
								--	--	--	--	77.9	66.4	3.5
	Avg							82.9	69.5	10.0	0.657	77.8	66.2	3.6
90		294014	2	860	CWQ	48	315	76.7	67.7	10.0	0.648	71.1	64.2	3.9
								76.9	68.2	7.9	0.653	66.3	64.2	1.2
	Avg							76.8	68.0	9.0	0.651	68.7	64.2	2.6
79		293188	2	860	CWQ	48	315	78.4	66.2	9.0	0.638	71.7	61.5	3.9
								--	--	--	--	74.6	61.7	7.2
	Avg							78.4	66.2	9.0	0.638	73.2	61.6	5.6

(a) Alloy 34 Al, 7.8 Zn, 2.5 Mg, 1.0 Cu, 3.5 Fe, 4.9 Ni, 0.09 Cr
87 Al, 7.6 Zn, 2.5 Mg, 1.1 Cu, 2.2 Fe, 2.3 Ni, 0.16 Cr
90 Al, 7.5 Zn, 2.4 Mg, 1.0 Cu, 1.1 Fe, 1.0 Ni, 0.20 Cr
79 Al, 6.8 Zn, 2.8 Mg, 2.1 Cu, 1.0 Mn, 0.5 Cr, 0.01 Zr

(b) One specimen per test unless noted.

(c) Avg. of 3 or more tests.

(d) Highest value of 3 or more test results.

(e) Lowest value of 3 or more test results.

(f) Failed before reaching 0.2% offset.

(g) Not obtained-specimen shattered.

(h) t = time in hours, T = Temp. in °F

(i) Data from S. No. 283445

TABLE XXI

THE EFFECT OF STEP AGING ON TENSILE PROPERTIES AND STRESS CORROSION CRACKING RESISTANCE OF ALLOY 2

S. NO. 277374 (a)

Additional Aging Time at 330°F-Hrs. (b)	Data Source	Longitudinal TS ksi	Longitudinal YS ksi	Longitudinal El, % In 4D	Longitudinal YS/Density x10⁶ In.	Transverse TS ksi	Transverse YS ksi	Transverse El, % In 4D	Unstressed TS ksi	Unstressed % Change	Stressed to 25% TS: TS ksi	Stressed to 25% TS: % Change	Stressed to 50% TS: TS, ksi or Days to Failure	Stressed to 50% TS: % Change	Stressed to 75% TS: TS, ksi or Days to Failure	Stressed to 75% TS: % Change
0	(c)	105.6	103.5	2.9	0.984	75.9	(d)	0.0	--	--	--	--	--	--	--	--
	(c)	105.6	103.1	2.9	0.980	85.1	(d)	0.0	--	--	--	--	--	--	--	--
	(e)	106.0	103.2	3.2	0.981	83.1	(f)	0	--	--	--	--	--	--	--	--
	(e)	105.7	102.7	3.2	0.976	73.0	(f)	0 (h)	--	--	--	--	--	--	--	--
	Avg.	105.8	103.1	3.0	0.980	79.3	--	0	--	--	--	--	--	--	--	--
4	(e)	91.5	89.7	4.7	0.853	77.0	(f)	0 (h)	--	--	--	--	--	--	--	--
	(e)	91.6	89.7	4.3	0.853	73.7	(f)	0	--	--	--	--	--	--	--	--
	Avg.	91.6	89.7	4.5	0.853	75.4	--	0	--	--	--	--	--	--	--	--
6	Predicted	88	85	5	--	74	--	1	--	--	--	--	--	--	--	--
	(g)	--	--	--	--	76.3	(f)	0.4	64.0	-17	41.2	-47	68 Da	-100	13 Da	-100
	(g)	--	--	--	--	78.1	77.6	0.6	57.4	-26	59.2	-23	40 Da	-100	11 Da	-100
	Avg.	--	--	--	--	77.2	--	0.5	60.7	-22	50.2	-35	--	-100	--	-100
8	Predicted	85	81	6	--	73	71	1	--	--	--	--	--	--	--	--
	(g)	--	--	--	--	73.9	(f)	0.3 (h)	54.6	-27	58.5	-22	39.7	-47	13 Da	-100
	(g)	--	--	--	--	75.2	75.0	0.4	61.8	-17	60.7	-19	38.9	-48	15 Da	-100
	Avg.	--	--	--	--	74.6	--	0.4	58.2	-22	59.6	-20	39.3	-47	--	-100
16	(e)	79.4	73.2	7.5	0.696	69.8	66.2	1.2	--	--	--	--	--	--	--	--
	(e)	79.4	72.5	8.0	0.689	68.1	65.8	1.2	--	--	--	--	--	--	--	--
	Avg.	79.4	72.8	7.8	0.692	69.0	66.0	1.2	--	--	--	--	--	--	--	--
18	Predicted	78	71	8	--	68	65	1	--	--	--	--	--	--	--	--
	(g)	--	--	--	--	69.8	67.4	1.1	58.0	-17	59.7	-14	55.9	-20	57 Da	-100
	(g)	--	--	--	--	69.8	67.6	0.9	53.5	-23	58.1	-17	56.6	-19	41 Da	-100
	Avg.	--	--	--	--	69.8	67.5	1.0	55.8	-20	58.9	-16	56.2	-19	--	-100
28	Predicted	74	66	9	--	65	62	1	--	--	--	--	--	--	--	--
	(g)	--	--	--	--	65.6	63.2	0.9	49.6	-25	54.1	-18	53.4	-19	61 Da	-100
	(g)	--	--	--	--	67.0	63.2	1.7	57.4	-13	56.6	-15	53.7	-19	46.1	-30
	Avg.	--	--	--	--	66.3	63.2	1.3	54.5	-19	55.4	-17	53.6	-19	--	-65
40	(e)	70.8	61.4	8.5	0.584	61.5	57.1	1.3	--	--	--	--	--	--	--	--
	(e)	71.2	61.7	9.5	0.587	61.6	57.0	1.4 (h)	--	--	--	--	--	--	--	--
	Avg.	71.0	61.6	9.0	0.586	61.6	57.0	1.4	--	--	--	--	--	--	--	--

Notes:
(a) 12.1 Zn, 3.5 Mg, 1.5 Cu, 0.5 Mn
(b) SHT 2 hrs. at 860°F, CWQ, Aged #1 24 hrs. at 250°F as 2 in. dia. piece.
(c) Table II Original tests
(d) Strain follower not used to avoid breaking it.
(e) Step Aged Data
(f) Failed before reaching 0.2% Offset.
(g) From stress corrosion data.
(h) Failed at or outside gage length.

TABLE XXII

THE EFFECT OF STEP AGING ON TENSILE PROPERTIES AND STRESS CORROSION CRACKING RESISTANCE OF ALLOY 3

S.NO. 277375 (a)

Additional Aging Time at 330°F-Hrs.(b)	Data Source	Longitudinal TS ksi	Longitudinal YS ksi	Longitudinal El, % In 4D	Longitudinal YS/Density x10⁶ In.	Transverse TS ksi	Transverse YS ksi	Transverse El, % In 4D	Unstressed TS ksi	Unstressed % Change	Stressed 25% TS TS ksi	Stressed 25% TS % Change	Stressed 50% TS TS,ksi or Days to Failure	Stressed 50% TS % Change	Stressed 75% TS TS,ksi or Days to Failure	Stressed 75% TS % Change
0	(c)	106.7	104.0	1.4	0.988	84.3	(d)	(e)	--	--	--	--	--	--	--	--
	(c)	105.6	103.1	0.7	0.980	90.9	(d)	0.0	--	--	--	--	--	--	--	--
	(f)	107.6	104.1	2.2	0.990	87.7	86.4	0.9	--	--	--	--	--	--	--	--
	(f)	108.2	104.8	2.3	0.996	82.8	(h)	0	--	--	--	--	--	--	--	--
	Avg.	107.0	104.0	1.9	0.988	86.4	86.4	0.3	--	--	--	--	--	--	--	--
3	Predicted	102	99	3	--	82	81	1	--	--	--	--	--	--	--	--
	(g)	--	--	--	--	77.8	(h)	0.4	51.4	-36	38.9	-51	24 Da	-100	3 Da	-100
	(g)	--	--	--	--	81.6	81.3	0.4	43.5	-45	44.9	-44	27 Da	-100	2 Da	-100
	Avg.	--	--	--	--	79.7	--	0.4	47.4	-40	41.9	-48	--	-100	--	-100
4	(f)	92.8	89.8	3.6	0.854	81.2	79.8	0.7	--	--	--	--	--	--	--	--
	(f)	92.6	89.7	3.0	0.853	80.7	78.7	1.0	--	--	--	--	--	--	--	--
	Avg.	92.7	89.8	3.3	0.854	81.0	79.2	0.8	--	--	--	--	--	--	--	--
7	Predicted	89	85	4	--	77	74	1	--	--	--	--	--	--	--	--
	(g)	--	--	--	--	80.8	77.9	0.7	55.9	-31	55.8	-31	49 Da	-100	9 Da	-100
	(g)	--	--	--	--	80.2	77.9	0.5	56.8	-29	48.0	-40	53 Da	-100	9 Da	-100
	Avg.	--	--	--	--	80.5	77.9	0.6	56.4	-30	51.9	-36	--	-100	--	-100
16	(f)	79.8	73.0	5.8	0.694	69.3	65.2	1.0	--	--	--	--	--	--	--	--
	(f)	79.8	72.9	5.4	0.693	69.8	65.7	0.8 (i)	--	--	--	--	--	--	--	--
	Avg.	79.8	73.0	5.6	0.694	69.6	65.4	0.9	--	--	--	--	--	--	--	--
17	Predicted	79	72	6	--	69	65	1	--	--	--	--	--	--	--	--
	(g)	--	--	--	--	72.0	68.1	0.7 (i)	54.1	-25	54.2	-25	49.0	-32	32 Da	-100
	(g)	--	--	--	--	71.5	68.2	0.7	57.3	-20	56.1	-22	51.9	-28	32 Da	-100
	Avg.	--	--	--	--	71.8	68.2	0.7	55.7	-22	55.2	-23	50.4	-30	--	-100
2[illegible]	Predicted	75	67	6	--	66	62	1	--	--	--	--	--	--	--	--
	(g)	--	--	--	--	71.3	65.3	2.0	54.4	-23	51.2	-27	45.7	-35	4[illegible] Da	-100
	(g)	--	--	--	--	69.3	65.7	1.1	54.5	-22	58.9	-16	57.6	-18	3 Da	-100
	Avg.	--	--	--	--	70.3	65.5	1.6	54.4	-23	55.0	-22	51.6	-26	--	-100
40	(f)	71.2	61.4	6.5	0.584	61.5	57.5	1.2	--	--	--	--	--	--	--	--
	(f)	71.9	61.9	6.5	0.588	63.6	57.0	1.7	--	--	--	--	--	--	--	--
	Avg.	71.6	61.6	6.5	0.586	62.6	57.2	1.4	--	--	--	--	--	--	--	--

Notes:
(a) 12.3 Zn, 4.0 Mg, 1.6 Cu, 0.5 Mn
(b) SHT 2 hrs. at 860°F, CWQ, Age #1 24 hrs. at 250°F as 2 in. dia. pieces.
(c) Original evaluation, Table II
(d) Strain follower not used to avoid breaking it.
(e) Not obtained - specimen shattered.
(f) Step aging tests.
(g) Stress corrosion data from (f)
(h) Failed before reaching of 2% offset.
(i) Specimen failed outside gage length.

TABLE XXIII

THE EFFECT OF STEP AGING OF TENSILE PROPERTIES AND STRESS CORROSION CRACKING RESISTANCE OF ALLOY 4

S.NO. 277376 (a)

Additional Aging Time @ 330°F-Hrs. (b)	Data Source	Longitudinal TS ksi	Longitudinal YS ksi	Longitudinal El, % In 4D	Longitudinal YS/Density x10^6 In.	Transverse TS ksi	Transverse YS ksi	Transverse El, % In 4D	Unstressed TS ksi	Unstressed % Change	Stressed 25% TS TS ksi	Stressed 25% TS % Change	Stressed 50% TS TS, ksi or Days to Failure	Stressed 50% TS % Change	Stressed 75% TS TS, ksi or Day to Failure	Stressed 75% TS % Change
0	c	103.5	10[illegible].7	2.1	0.967	72.9	(d)	0.0	--	--	--	--	--	--	--	--
	c	10[illegible]	99.6	1.4	0.963	85.5	(d)	0.0	--	--	--	--	--	--	--	--
	e	10[illegible]	100.6	2.4	0.966	79.7	(h)	0.1(g)	--	--	--	--	--	--	--	--
	e	105.7	10[illegible].8	4.1	0.968	82.5	(h)	0.1(g)	--	--	--	--	--	--	--	--
	Avg.	[illegible]	100.4	2.5	0.964	80.2	--	0.0	--	--	--	--	--	--	--	--
4	e	94.[illegible]	89.1	5.5	0.656	77.7	77.7	0.4	--	--	--	--	--	--	--	--
	e	93.7	88.7	6.[illegible]	0.652	72.4	(h)	0.0	--	--	--	--	--	--	--	--
	Avg.	9[illegible].6	88.9	5.8	0.654	75.0	77.7	0.2	--	--	--	--	--	--	--	--
6	Predicted	84	8[illegible]	-	--	77	74	1	--	--	--	--	--	--	--	--
	f	--	--	--	--	71.6	(h)	0.1(g)	38.0	-47	44.3	-39	33 Da	-100	1 Da	-100
	f	--	--	--	--	73.0	(h)	0.2	35.6	-51	37.5	-48	37 Da	-100	2 Da	-100
	Avg.	--	--	--	--	72.3	--	0.2	36.8	-49	40.9	-44	--	-100	--	-100
8	Predicted	88	81	6	--	72	71	1	--	--	--	--	--	--	--	--
	f	--	--	--	--	76.6	75.2	0.5	44.3	--	44.0	-42	15 Da	-100	2 Da	-100
	f	--	--	--	--	76.1	75.2	0.7	42.4	-42	41.1	-46	16 Da	-100	3 Da	-100
	Avg.	--	--	--	--	76.4	75.2	0.6	43.4	-43	42.6	-44	--	-100	--	-100
16	e	80.6	71.4	7.[illegible]	0.686	70.7	67.1	1.2	--	--	--	--	--	--	--	--
	e	81.2	72.[illegible]	7.5	0.695	68.1	66.1	1.1	--	--	--	--	--	--	--	--
	Avg.	8[illegible]	71.8	7.2	0.690	69.4	66.6	1.2	--	--	--	--	--	--	--	--
[illegible]	Predicted	79	7[illegible]	-	--	68	65	1	--	--	--	--	--	--	--	--
		--	-	--	--	69.7	67.2	0.9	39.8	-43	53.3	-23	15 Da	-100	7 Da	-100
	f	--	--	--	--	69.2	66.7	0.9	41.9	-40	44.8	-35	41 Da	-100	9 Da	-100
	Avg.	--	--	--	--	69.4	67.0	0.8	40.8	-41	49.0	-29	--	-100	--	-100
[illegible]	Predicted	76	6[illegible]	7	--	65	62	1	--	--	--	--	--	--	--	--
	f	--	--	--	--	63.4	61.6	0.9(g)	40.1	-40	45.2	-33	49 Da	-100	11 Da	-100
	f	--	--	--	--	70.7	64.1	0.3	45.0	-33	45.0	-33	69 Da	-100	9 Da	-100
	Avg.	--	--	--	--	67.0	63.0	0.6	42.6	-36	45.1	-33	--	-100	--	-100
48	e	73.[illegible]	61.6	7.5	[illegible]	63.[illegible]	57.0	2.0	--	--	--	--	--	--	--	--
	e	73.4	62.1	6.5 (g)	[illegible]	5[illegible]	57.0	0.2 (g)	--	--	--	--	--	--	--	--
	Avg.	73.4	61.8	7.[illegible]	[illegible]	60.6	57.0	1.1	--	--	--	--	--	--	--	--

Notes: (a) [illegible].6 Zn, [illegible].2 Mg, [illegible] Cu, [illegible].2 Cr.
(b) [illegible] hrs. at [illegible]°F, CWQ, Age #1 24 hrs. at 250°F as 2 in. dia. piece.
(c) Original Evaluation - Table [illegible]
(d) Strain follower not used to avoid breaking it.
(e) Step Aging Data.
f Stress corrosion data.
g Specimen failed at or outside gage mark.
h Specimen failed before reaching 0.2% offset.

Table XXIV

THE EFFECT OF STEP AGING ON TENSILE PROPERTIES AND STRESS CORROSION CRACKING RESISTANCE OF ALLOY 5

S. No. 277377 (a)

Additional Aging Time at 330°F, Hrs(b)	Data Source	Longitudinal T.S. ksi	Longitudinal Y.S. ksi	Longitudinal El, % in 4D	Longitudinal Y.S./Density x 10^6 in	Transverse T.S. ksi	Transverse Y.S. ksi	Transverse El, % in 4D	Unstressed T.S. ksi	Unstressed % Change	Stressed 25% T.S. T.S. ksi	Stressed 25% T.S. % Change	Stressed 50% T.S. T.S., ksi or Days to Failure	Stressed 50% T.S. % Change	Stressed 75% T.S. T.S., ksi or Days to Failure	Stressed 75% T.S. % Change
0	(c)	103.8	101.0	1.4	0.951	70.6	(d)	0.0	----	----	----	----	--------	----	--------	----
	(c)	107.4	103.7	1.4	0.976	69.9	(d)	0.0	----	----	----	----	--------	----	--------	----
	(e)	[illegible]	103.7	1.4	0.976	74.8	(d)	0	----	----	----	----	--------	----	--------	----
	(e)	106.8	100.6	3.0	0.947	75.6	(h)	0	----	----	----	----	--------	----	--------	----
	Avg.	106.3	102.2	1.8	0.962	77.7	---	0	----	----	----	----	--------	----	--------	----
4	(e)	93.5	86.0	3.1(g)	0.810	70.5	(d)	0	----	----	----	----	--------	----	--------	----
	(e)	96.1	88.8	4.0	0.836	74.9	(d)	0	----	----	----	----	--------	----	--------	----
	Avg.	94.8	87.4	3.6	0.823	72.7	---	0	----	----	----	----	--------	----	--------	----
16	(e)	85.2	72.8	6.0	0.685	56.1	66.1	0.4	----	----	----	----	--------	----	--------	----
	(e)	84.5	72.6	3.5(g)	0.684	67.5	57.8	0.8	----	----	----	----	--------	----	--------	----
	Avg.	84.8	72.7	4.8	0.685	66.8	66.0	0.6	----	----	----	----	--------	----	--------	----
17	Predicted	84	72	5	-----	66	65	< 1	----	----	----	----	--------	----	--------	----
	(f)	----	----	----	-----	67.0	(h)	0.7	54.6	-19	40.6	-40	22.9	-66	3 days	-100
	(f)	----	----	----	-----	67.6	67.5	0.4(g)	49.8	-26	38.9	-42	47.4	-30	9 days	-100
	Avg.	----	----	----	-----	67.3	----	0.6	52.2	-22	39.8	-41	35.2	-48	--------	-100
25	Predicted	81	67	5	-----	64	62	1	----	----	----	----	--------	----	--------	----
	(f)	----	----	----	-----	64.4	63.4	0.7(g)	51.6	-21	39.6	-39	51.9	-20	44 days	-100
	(f)	----	----	----	-----	65.5	63.6	0.8	55.0	-15	52.5	-19	41.2	-37	11 days	-100
	Avg.	----	----	----	-----	65.0	63.5	0.8	53.4	-18	46.0	-29	46.6	-28	--------	-100
40	(e)	76.8	61.8	7.0	0.582	61.8	57.1	1.5	----	----	----	----	--------	----	--------	----
	(e)	77.8	62.3	7.0	0.587	59.5	56.6	1.3	----	----	----	----	--------	----	--------	----
	Avg.	77.3	62.0	7.0	0.584	60.6	56.8	1.4	----	----	----	----	--------	----	--------	----

NOTE:
(a) Al, 10.3 Zn, 2.9 Mg, 2.1 Cu, 1.8 Mn, 0.1 Cr
(b) SHT 2 hrs at 860°F, CWQ, Age #1 24 hrs at 250°F as 2 in. dia. pieces
(c) Original evaluation - Table II
(d) Strain follower not used to avoid breaking it
(e) Step aging data
(f) Stress corrosion data
(g) Specimen failed outside gage length
(h) Specimen failed before reaching 0.2% offset

Table XXV

THE EFFECT OF STEP AGING ON TENSILE PROPERTIES AND STRESS CORROSION CRACKING RESISTANCE OF ALLOY 6

S. No. 277378 (a)

Additional Aging Time at 330°F, Hrs(b)	Data Source	Longitudinal T.S. ksi	Longitudinal Y.S. ksi	Longitudinal El, % in 4D	Longitudinal Y.S./Density x 10⁶ in	Transverse T.S. ksi	Transverse Y.S. ksi	Transverse El, % in 4D	Unstressed T.S. ksi	Unstressed % Change	Stressed 25% T.S. T.S. ksi	Stressed 25% T.S. % Change	Stressed 50% T.S. T.S., ksi, or Days to Failure	Stressed 50% T.S. % Change	Stressed 75% T.S. T.S., ksi, or Days to Failure	Stressed 75% T.S. % Change
0	(c)	104.2	99.9	4.3	0.942	87.1	(d)	0.0	----	----	----	----	-------	----	-------	----
	(c)	103.7	98.9	3.6	0.933	89.0	85.7	1.9	----	----	----	----	-------	----	-------	----
	(e)	106.3	100.6	7.0	0.949	83.9	82.8	0.2(g)	----	----	----	----	-------	----	-------	----
	(e)	-----	-----	----	-----	84.2	83.2	0.4(g)	----	----	----	----	-------	----	-------	----
	Avg.	104.7	99.8	5.0	0.942	86.0	83.9	0.6	----	----	----	----	-------	----	-------	----
4	(e)	93.1	89.0	7.0	0.840	78.0	76.6	0.2(g)	----	----	----	----	-------	----	-------	----
	(e)	-----	-----	----	-----	79.6	77.9	0.4(g)	----	----	----	----	-------	----	-------	----
	Avg.	93.1	89.0	7.0	0.840	78.8	77.2	0.3	----	----	----	----	-------	----	-------	----
6	Predicted	90	85	8	-----	76	74	1	----	----	----	----	-------	----	-------	----
	(f)	-----	----	----	-----	78.8	76.3	1.4	67.9	-14	----	----	30 days	-100	6 days	-100
	(f)	-----	----	----	-----	79.1	76.4	1.8	67.7	-14	58.8	-26	18 days	-100	5 days	-100
	Avg.	-----	----	----	-----	79.0	76.4	1.6	67.8	-14	58.8	-26	-------	-100	-------	-100
16	(e)	80.8	73.0	10.5	0.689	70.2	65.8	2.0	----	----	----	----	-------	----	-------	----
	(e)	-----	----	----	-----	69.8	65.8	2.8	----	----	----	----	-------	----	-------	----
	Avg.	80.8	73.0	10.5	0.689	70.0	65.8	2.4	----	----	----	----	-------	----	-------	----
17	Predicted	80	72	10	-----	69	65	2	----	----	----	----	-------	----	-------	----
	(f)	-----	----	----	-----	68.8	67.1	1.7	63.3	-10	59.2	-16	47 days	-100	23 days	-100
	(f)	-----	----	----	-----	71.5	67.1	2.6(g)	61.5	-12	60.7	-14	60 days	-100	23 days	-100
	Avg.	-----	----	----	-----	70.2	67.1	2.2	62.4	-11	60.0	-15	-------	-100	-------	-100
24	Predicted	77	69	12	-----	68	62	3	----	----	----	----	-------	----	-------	----
	(f)	-----	----	----	-----	69.9	64.6	2.1(g)	61.3	-12	58.2	-16	54.6	-21	11 days	-100
	(f)	-----	----	----	-----	68.7	64.2	1.9(g)	61.1	-12	58.0	-16	40 days	-100	20 days	-100
	Avg.	-----	----	----	-----	69.3	64.4	2.0	61.2	-12	58.1	-16	-------	-60	-------	-100
40	(e)	75.6	65.9	10.5	0.622	66.8	60.0	3.7	----	----	----	----	-------	----	-------	----
	(e)	-----	----	----	-----	67.4	59.5	3.9	----	----	----	----	-------	----	-------	----
	Avg.	75.6	65.9	10.5	0.622	67.1	59.8	3.8	----	----	----	----	-------	----	-------	----

NOTE:
(a) Al, 11.2 Zn, 2.4 Mg, 2.0 Cu, 0.2 Cr
(b) SHT 2 hrs at 860°F, CWQ, Age #1 24 hrs at 250°F as 2 in dia. piece
(c) Original evaluation - Table II
(d) Strain follower not used to avoid breaking it
(e) Step aging data
(f) Stress corrosion data
(g) Specimen failed outside gage length

Table XXVI

THE EFFECT OF STEP AGING ON TENSILE PROPERTIES AND STRESS CORROSION CRACKING RESISTANCE OF ALLOY 19

S. No. 277391 (a)

Additional Aging Time at 330°F, Hrs(b)	Data Source	Longitudinal T.S. ksi	Longitudinal Y.S. ksi	Longitudinal El, % in 4D	Longitudinal Y.S./Density x 10⁶ in	Transverse T.S. ksi	Transverse Y.S. ksi	Transverse El, % in 4D	Unstressed T.S. ksi	Unstressed % Change	Stressed 25% T.S. T.S. ksi	Stressed 25% T.S. % Change	Stressed 50% T.S. T.S., ksi, or Days to Failure	Stressed 50% T.S. % Change	Stressed 75% T.S. T.S., ksi, or Days to Failure	Stressed 75% T.S. % Change
0	(c)	101.9	95.9	6.4	0.942	84.1	(d)	0.0	----	----	----	----	-------	----	-------	----
	(c)	100.6	94.7	7.9	0.930	87.5	(d)	1.9	----	----	----	----	-------	----	-------	----
	(e)	102.4	97.0	7.0	0.953	86.6	78.0	2.2	----	----	----	----	-------	----	-------	----
	(e)	102.2	96.9	7.0	0.952	85.9	78.5	0.2	----	----	----	----	-------	----	-------	----
	Avg.	101.8	96.1	7.1	0.944	86.0	78.2	1.1	----	----	----	----	-------	----	-------	----
4	(e)	93.3	88.4	9.0	0.868	84.0	77.5	3.1(g)	----	----	----	----	-------	----	-------	----
	(e)	93.4	88.4	9.5	0.868	83.3	77.5	3.3	----	----	----	----	-------	----	-------	----
	Avg.	93.4	88.4	9.2	0.868	83.6	77.5	3.2	----	----	----	----	-------	----	-------	----
8	Predicted	88	83	10	-----	81	74	4	----	----	----	----	-------	----	-------	----
	(f)	-----	----	----	-----	79.4	74.0	2.8	72.5	-10	67.7	-16	60 days	-100	24 days	-100
	(f)	-----	----	----	-----	81.3	74.4	4.2	71.6	-11	67.9	-16	44 days	-100	32 days	-100
	Avg.	-----	----	----	-----	80.4	74.2	3.5	72.0	-10	67.8	-16	-------	-100	-------	-100
12	Predicted	85	79	10	-----	78	71	5	----	----	----	----	-------	----	-------	----
	(f)	-----	----	----	-----	76.3	72.0	2.9	70.1	-9	68.6	-11	54 days	-100	34 days	-100
	(f)	-----	----	----	-----	78.5	72.4	5.2	65.8	-15	66.9	-14	57 days	-100	32 days	-100
	Avg	-----	----	----	-----	77.4	72.2	4.0	68.0	-12	67.8	-12	-------	-100	-------	-100
16	(e)	82.0	74.5	10.5	0.732	76.4	67.4	6.6	----	----	----	----	-------	----	-------	----
	(e)	83.1	75.9	10.5	0.746	74.8	66.5	3.5(g)	----	----	----	----	-------	----	-------	----
	Avg.	82.6	75.2	10.5	0.739	75.6	67.0	5.0	----	----	----	----	-------	----	-------	----
19	Predicted	81	73	11	-----	74	65	6	----	----	----	----	-------	----	-------	----
	(f)	-----	----	----	-----	76.3	67.9	5.2	66.3	-13	60.7	-20	34.9	-54	44 days	-100
	(f)	-----	----	----	-----	76.0	67.9	4.2	67.1	-12	64.8	-15	49.8	-35	50 days	-100
	Avg.	-----	----	----	-----	76.2	67.9	4.7	66.7	-12	62.8	-18	42.4	-44	-------	-100
25	Predicted	78	70	11	-----	72	62	7	----	----	----	----	-------	----	-------	----
	(f)	-----	----	----	-----	74.6	65.2	5.7	64.8	-12	60.6	-18	42.7	-42	57 days	-100
	(f)	-----	----	----	-----	73.4	65.6	3.9	65.1	-12	59.5	-20	46.0	-38	47 days	-100
	Avg.	-----	----	----	-----	74.0	65.4	4.8	65.0	-12	60.0	-19	44.4	-40	-------	-100
40	(e)	75.2	65.2	12.0	0.640	70.7	59.1	8.4	----	----	----	----	-------	----	-------	----
	(e)	74.1	63.8	12.5	0.627	70.7	59.1	9.2	----	----	----	----	-------	----	-------	----
	Avg.	74.6	64.5	12.2	0.634	70.7	59.1	8.8	----	----	----	----	-------	----	-------	----

NOTE:
(a) Al, 7.5 Zn, 3.0 Mg, 1.7 Cu
(b) SHT 2 hrs at 860°F, CWQ, Age #1 24 hrs at 250°F as 2 in dia. pieces
(c) Original evaluation - Table II
(d) Strain follower not used to avoid breaking it
(e) Step aging data
(f) Stress corrosion data
(g) Specimen failed outside gage length

Table XXVII

THE EFFECT OF STEP AGING ON TENSILE PROPERTIES AND STRESS CORROSION CRACKING RESISTANCE OF ALLOY 20

S. No. 277392 (a)

Additional Aging Time at 330°F, Hrs(b)	Data Source	Longitudinal T.S. ksi	Longitudinal Y.S. ksi	Longitudinal El, % in 4D	Longitudinal Y.S./Density x 10^6 in	Transverse T.S. ksi	Transverse Y.S. ksi	Transverse El, % in 4D	Unstressed T.S. ksi	Unstressed % Change	Stressed 25% T.S. T.S. ksi	Stressed 25% T.S. % Change	Stressed 50% T.S. T.S., ksi, or Days to Failure	Stressed 50% T.S. % Change	Stressed 75% T.S. T.S., ksi, or Days to Failure	Stressed 75% T.S. % Change
0	(c)	101.0	95.2	4.3	0.932	84.2	(d)	0.0	----	----	----	----	-------	----	-------	----
	(c)	99.6	94.4	3.6	0.924	90.3	(d)	3.7	----	----	----	----	-------	----	-------	----
	(e)	102.4	97.2	6.5	0.952	86.6	79.5	2.2	----	----	----	----	-------	----	-------	----
	(e)	102.4	97.1	6.5	0.951	85.3	79.5	1.2	----	----	----	----	-------	----	-------	----
	Avg.	101.4	96.0	5.2	0.940	86.6	79.5	1.8	----	----	----	----	-------	----	-------	----
4	(e)	95.0	90.1	7.0	0.882	81.6	78.3	1.1	----	----	----	----	-------	----	-------	----
	(e)	95.4	90.1	7.0	0.882	83.6	77.9	1.6	----	----	----	----	-------	----	-------	----
	Avg.	95.2	90.1	7.0	0.882	82.6	78.1	1.3	----	----	----	----	-------	----	-------	----
8	Predicted	91	85	8	-----	80	74	2	----	----	----	----	-------	----	-------	----
	(f)	-----	----	----	-----	79.5	76.4	1.2	64.0	-19	56.6	-29	35 days	-100	9 days	-100
	(f)	-----	----	----	-----	79.4	76.4	1.0	65.7	-17	64.5	-19	24 days	-100	7 days	-100
	Avg.	-----	----	----	-----	79.4	76.4	1.1	64.8	-18	60.6	-24	-------	-100	-------	-100
13	Predicted	87	81	8	-----	78	71	3	----	----	----	----	-------	----	-------	----
	(f)	-----	----	----	-----	80.[illegible]	73.2	3.9	64.1	-19	64.1	-19	47 days	-100	26 days	-100
	(f)	-----	----	----	-----	77.1	73.2	1.6	65.8	-17	65.8	-17	45 days	-100	17 days	-100
	Avg.	-----	----	----	-----	78.9	73.2	2.8	65.0	-18	65.0	-18	-------	-100	-------	-100
16	(e)	85.5	78.6	8.0	0.770	76.4	69.3	2.9	----	----	----	----	-------	----	-------	----
	(e)	85.3	78.3	9.0	0.767	77.2	69.5	3.0	----	----	----	----	-------	----	-------	----
	Avg.	85.4	78.4	8.5	0.768	76.8	69.4	3.0	----	----	----	----	-------	----	-------	----
28	Predicted	81	72	9	-----	73	65	4	----	----	----	----	-------	----	-------	----
	(f)	-----	----	----	-----	74.4	66.7	3.1	57.8	-23	53.9	-28	42.9	-43	33 days	-100
	(f)	-----	----	----	-----	75.0	66.7	3.1	59.3	-21	59.3	-21	77 days	-100	35 days	-100
	Avg.	-----	----	----	-----	74.7	66.7	3.1	58.6	-22	56.6	-24	-------	-72	-------	-100
40	(e)	77.8	68.5	10.0	0.671	71.4	62.1	4.6	----	----	----	----	-------	----	-------	----
	(e)	76.6	66.9	10.5	0.655	71.2	62.1	3.7	----	----	----	----	-------	----	-------	----
	(f)	-----	----	----	-----	72.8	63.9	4.4	55.9	-23	57.7	-21	53.6	-26	44 days	-100
	(f)	-----	----	----	-----	72.8	63.4	4.4	57.6	-21	58.1	-20	44.2	-39	48 days	-100
	Avg.	77.2	67.7	10.2	0.663	72.0	62.9	4.3	56.8	-22	57.9	-20	48.9	-32	-------	-100

NOTE: (a) Al, 7.[illegible] Zn, 3.6 Mg, 2.3 Cu
(b) SHT 2 hrs at 860°F, CWQ, Age #1 24 hrs at 250°F as 2 in dia. piece
(c) Original data - Table II
(d) Strain follower not used to avoid breaking it
(e) Step aging data
(f) Stress corrosion data

Table XXVIII

THE EFFECT OF STEP AGING ON TENSILE PROPERTIES AND STRESS CORROSION CRACKING RESISTANCE OF ALLOY 28

S. No. 277400 (a)

Additional Aging Time at 330°F-Hrs. (b)	Data Source	Longitudinal TS ksi	Longitudinal YS ksi	Longitudinal El, % In 4D	Longitudinal YS/Density x10⁶ In.	Transverse TS ksi	Transverse YS ksi	Transverse El, % In 4D	Unstressed TS ksi	Unstressed % Change	Stressed 25% TS: TS, ksi or Days to Failure	Stressed 25% TS: % Change	Stressed 50% TS: TS, ksi or Days to Failure	Stressed 50% TS: % Change	Stressed 75% TS: TS, ksi or Days to Failure	Stressed 75% TS: % Change
0	(c)	102.7	99.9	2.9	0.959	89.0	(d)	0.0	--	--	--	--	--	--	--	--
	(c)	101.2	97.7	2.1	0.938	89.2	(d)	1.9	--	--	--	--	--	--	--	--
	(e)	103.8	100.2	2.8	0.962	87.4	83.1	1.3	--	--	--	--	--	--	--	--
	(e)	103.5	99.9	3.1	0.959	85.6	81.5	1.1	--	--	--	--	--	--	--	--
	Avg.	102.8	99.4	2.7	0.954	87.8	82.3	1.1	--	--	--	--	--	--	--	--
1	Predicted	101	97	3	--	85	81	1	--	--	--	--	--	--	--	--
	(f)	--	--	--	--	84.8	81.3	1.1	68.8	-20	50.6	-41	1 Da	-100	1 Da	-100
	(f)	--	--	--	--	86.7	81.6	0.9(g)	71.2	-17	65.1	-24	1 Da	-100	1 Da	-100
	Avg.	--	--	--	--	85.8	81.4	1.0	70.0	-18	57.8	-32	--	-100	--	-100
4	(e)	93.1	89.7	5.0	0.861	81.7	78.8	1.3	--	--	--	--	--	--	--	--
	(e)	93.2	90.1	3.8	0.865	80.6	78.3	0.9	--	--	--	--	--	--	--	--
	Avg.	93.2	89.9	4.4	0.863	81.2	78.6	1.1	--	--	--	--	--	--	--	--
8	Predicted	87	83	5	--	77	74	1	--	--	--	--	--	--	--	--
	(f)	--	--	--	--	79.8	76.2	1.4	63.0	-21	62.0	-23	--	--	11 Da	-100
	(f)	--	--	--	--	80.4	76.9	1.4	59.5	-26	64.9	-19	37 Da	-100	11 Da	-100
	Avg.	--	--	--	--	80.1	76.6	1.4	61.2	-24	63.4	-21	--	-100	--	-100
16	(e)	81.5	75.0	6.5	0.720	72.3	67.9	0.9	--	--	--	--	--	--	--	--
	(e)	82.4	75.6	5.5	0.726	72.9	68.3	1.9	--	--	--	--	--	--	--	--
	Avg.	82.0	75.3	6.0	0.723	72.6	68.1	1.4	--	--	--	--	--	--	--	--
22	Predicted	79	71	6	--	70	65	1	--	--	--	--	--	--	--	--
	(f)	--	--	--	--	73.0	68.2	2.5	57.6	-20	58.8	-19	57.1	-21	32 Da	-100
	(f)	--	--	--	--	71.5	68.2	1.5	57.1	-21	56.3	-22	42.7	-41	29 Da	-100
	Avg.	--	--	--	--	72.2	68.2	2.0	57.4	-21	57.6	-20	49.9	-31	--	-100
32	Predicted	76	67	7	--	67	62	1	--	--	--	--	--	--	--	--
	(f)	--	--	--	--	65.1	63.2	0.9	53.6	-21	56.2	-17	54.1	-20	26 Da	-100
	(f)	--	--	--	--	71.1	64.5	2.8	53.9	-21	55.7	-18	53.4	-21	49 Da	-100
	Avg.	--	--	--	--	68.0	63.8	1.8	53.8	-21	56.0	-18	53.8	-21	--	-100
40	(e)	74.7	65.7	8.5	0.631	66.0	60.9	1.6(g)	--	--	--	--	--	--	--	--
	(e)	73.5	64.4	8.0	0.618	65.2	60.0	1.7	--	--	--	--	--	--	--	--
	Avg.	74.1	65.0	8.2	0.624	65.6	60.4	1.6	--	--	--	--	--	--	--	--

Notes:
(a) Al, 5.8 Zn, 3.8 Mg, 2.3 Cu.
(b) SHT 2 hrs. at 860°F, CWQ, Age #1 24 hrs. at 250°F as 2 in. dia. piece.
(c) Original Data - Table II Section III
(d) Strain follower not used to avoid breaking it.
(e) Step Aging Data.
(f) Stress corrosion data.
(g) Specimen failed through gage mark.

Table XXIX

THE EFFECT OF STEP AGING ON TENSILE PROPERTIES AND STRESS CORROSION CRACKING RESISTANCE ON ALLOY 33

S. No. 277405 (a)

Additional Aging Time at 330°F, Hrs(b)	Data Source	Longitudinal T.S. ksi	Longitudinal Y.S. ksi	Longitudinal El, % in 4D	Longitudinal Y.S./Density x 10⁶ in	Transverse T.S. ksi	Transverse Y.S. ksi	Transverse El, % in 4D	Unstressed T.S. ksi	Unstressed % Change	Stressed 25% T.S. T.S. ksi	Stressed 25% T.S. % Change	Stressed 50% T.S. T.S., ksi, or Days to Failure	Stressed 50% T.S. % Change	Stressed 75% T.S. T.S., ksi, or Days to Failure	Stressed 75% T.S. % Change
0	(c)	107.7	104.0	2.1	1.007	81.8	(d)	(e)	----	----	----	----	-------	----	-------	----
	(c)	108.2	104.4	1.4	1.012	82.9	(d)	0.0	----	----	----	----	-------	----	-------	----
	(f)	109.6	105.1	2.7	1.018	74.4	(h)	0	----	----	----	----	-------	----	-------	----
	(f)	108.4	104.5	2.4	1.013	76.9	(h)	0	----	----	----	----	-------	----	-------	----
	Avg.	108.5	104.5	2.2	1.013	79.0	---	0	----	----	----	----	-------	----	-------	----
4	(f)	96.5	90.6	5.3	0.878	75.0	(h)	0	----	----	----	----	-------	----	-------	----
	(f)	95.3	89.8	4.9	0.870	67.1	(h)	0	----	----	----	----	-------	----	-------	----
	Avg.	96.4	90.2	5.1	0.874	71.0	---	0	----	----	----	----	-------	----	-------	----
12	Predicted	87	79	7	-----	71	---	<1	----	----	----	----	-------	----	-------	----
	(g)	-----	-----	---	-----	70.1	(h)	1.2	60.4	-13	57.0	-18	75 days	-100	11 days	-100
	(g)	-----	-----	---	-----	68.9	(h)	0.3(i)	63.9	-8	60.2	-13	58.1	-16	11 days	-100
	Avg.	-----	-----	---	-----	69.5	---	0.8	62.2	-11	58.6	-16	-------	-58	-------	-100
16	(f)	85.8	76.4	7.0	0.740	70.0	69.2	1.2	----	----	----	----	-------	----	-------	----
	(f)	85.5	75.9	7.5	0.735	69.8	68.3	0.7	----	----	----	----	-------	----	-------	----
	Avg.	85.6	76.2	7.2	0.738	69.9	68.7	1.0	----	----	----	----	-------	----	-------	----
26	Predicted	81	71	7	-----	67	65	1	----	----	----	----	-------	----	-------	----
	(g)	-----	-----	---	-----	69.6	66.0	2.1	62.0	-10	60.2	-13	59.9	-13	24 days	-100
	(g)	-----	-----	---	-----	68.4	66.4	1.3	62.7	-9	58.9	-15	54.9	-22	21 days	-100
	Avg.	-----	-----	---	-----	69.0	66.2	1.7	62.4	-10	59.6	-14	57.0	-17	-------	-100
35	Predicted	79	67	7	-----	64	62	1	----	----	----	----	-------	----	-------	----
	(g)	-----	-----	---	-----	64.1	62.3	0.5	57.5	-11	56.7	-12	59.4	-8	41 days	-100
	(g)	-----	-----	---	-----	64.6	62.7	1.0	58.9	-9	57.5	-11	59.6	-7	35 days	-100
	Avg	-----	-----	---	-----	64.4	62.5	0.8	58.2	-10	57.1	-11	59.5	-8	-------	-100
40	(f)	77.6	65.2	7.0	0.632	62.6	60.9	1.2	----	----	----	----	-------	----	-------	----
	(f)	77.3	65.2	8.0	0.632	61.8	59.8	1.2	----	----	----	----	-------	----	-------	----
	Avg.	77.4	65.2	7.5	0.632	62.2	60.4	1.2	----	----	----	----	-------	----	-------	----

NOTE:
(a) Al, 9.0 Zn, 3.5 Mg, 1.2 Cu, 1.1 Mn
(b) SHT 2 hrs at 860°F, CWQ, Age #1 24 hrs at 250°F as 2 in dia. pieces
(c) Original evaluation - Table II
(d) Strain follower not used to avoid breaking it
(e) Not determined - Specimen shattered
(f) Step aging data
(g) Stress corrosion data
(h) Failed before reaching 0.2% offset
(i) Failed outside of at gage length

Table XXX

THE EFFECT OF STEP AGING ON TENSILE PROPERTIES AND STRESS CORROSION CRACKING RESISTANCE OF ALLOY 36

S. No. 277938 (a)

Additional Aging Time at 330°F, Hrs(b)	Data Source	Longitudinal T.S. ksi	Longitudinal Y.S. ksi	Longitudinal El, % in 4D	Longitudinal Y.S./Density x 10⁶ in	Transverse T.S. ksi	Transverse Y.S. ksi	Transverse El, % in 4D	Unstressed T.S. ksi	Unstressed % Change	Stressed 25% T.S. T.S. ksi	Stressed 25% T.S. % Change	Stressed 50% T.S. T.S., ksi or Days to Failure	Stressed 50% T.S. % Change	Stressed 75% T.S. T.S., ksi, or Days to Failure	Stressed 75% T.S. % Change
0	(c)	95.4	95.2	0.5	0.900	----	----	----	----	----	----	----	-------	----	-------	----
	(d)	105.2	101.0	1.3	0.955	74.8	(e)	0.0	----	----	----	----	-------	----	-------	----
	(d)	104.1	101.4	0.7	0.958	55.6(f)	(e)	0(f)	----	----	----	----	-------	----	-------	----
	(g)	104.7	100.4	1.1(i)	0.949	85.2	(e)	0	----	----	----	----	-------	----	-------	----
	(g)	----	-----	----	-----	66.3	(e)	0	----	----	----	----	-------	----	-------	----
	Avg.	102.4	99.5	0.9	0.940	70.5	---	0	----	----	----	----	-------	----	-------	----
4	(g)	92.0	87.7	1.4	0.829	79.1	(e)	0(i)	----	----	----	----	-------	----	-------	----
	(g)	----	----	----	-----	68.7	(e)	0	----	----	----	----	-------	----	-------	----
	Avg.	92.0	87.7	1.4	0.829	73.9	---	0	----	----	----	----	-------	----	-------	----
16	(g)	84.1	74.8	3.0	0.707	70.0	69.4	0.1(i)	----	----	----	----	-------	----	-------	----
	(g)	----	----	---	-----	70.1	69.8	0.6	----	----	----	----	-------	----	-------	----
	Avg.	84.1	74.8	3.0	0.707	70.0	69.6	0.4	----	----	----	----	-------	----	-------	----
28	Predicted	80	70	3	-----	68	65	1	----	----	----	----	-------	----	-------	----
	(h)	----	----	---	-----	68.6	66.4	0.8	55.7	-20	50.9	-26	48.7	-30	7 days	-100
	(h)	----	----	---	-----	69.9	66.3	1.2	49.8	-28	46.5	-33	48.5	-30	7 days	-100
	Avg.	----	----	---	-----	69.2	66.4	1.0	52.8	-24	48.7	-30	48.6	-30	-------	-100
36	Predicted	79	67	3	-----	67	62	1	----	----	----	----	-------	----	-------	----
	(h)	----	----	---	-----	65.4	63.4	0.9	52.3	-21	53.4	-20	51.7	-22	21 days	-100
	(h)	----	----	---	-----	67.8	64.2	1.4	51.9	-22	54.2	-19	52.2	-22	69 days	-100
	Avg.	----	----	---	-----	66.6	63.8	1.2	52.1	-22	53.8	-19	52.0	-22	-------	-100
40	(g)	78.0	66.2	3.2(i)	0.626	65.2	61.5	0.9	----	----	----	----	-------	----	-------	----
	(g)	----	----	---	-----	67.4	62.0	1.6	----	----	----	----	-------	----	-------	----
	Avg.	78.0	66.2	3.2	0.626	66.3	61.8	1.2	----	----	----	----	-------	----	-------	----

NOTE: (a) Al, 10.6 Zn, 4.4 Mg, 2.0 Cu, 1.7 Mn-14 microns
(b) SHT 2 hrs at 860°F, CWQ, Age #1 24 hrs at 250°F 2 in.dia. pieces
(c) Table VII, Section II
(d) Table II, Section III
(e) Failed before reaching 0.2% offset
(f) Specimen contained discontinuity
(g) Step aging data
(h) Stress corrosion data
(i) Specimen failed at or outside of gage marks

Table XXXI

THE EFFECT OF STEP AGING ON TENSILE PROPERTIES AND STRESS CORROSION CRACKING RECISTANCE OF ALLOY 36

S.No. 277939 (a)

Additional Aging Time at 330°F-Hrs.(b)	Data Source	Longitudinal TS ksi	Longitudinal YS ksi	Longitudinal El, % In 4D	Longitudinal YS/Density x10⁶ In.	Transverse TS ksi	Transverse YS ksi	Transverse El, % In 4D	Unstressed TS ksi	Unstressed % Change	Stressed 25% TS TS ksi	Stressed 25% TS % Change	Stressed 50% TS TS,ksi or Days to Failure	Stressed 50% TS % Change	Stressed 75% TS TS,ksi or Days to Failure	Stressed 75% TS % Change
0	(c)	94.5	92.2	0.6	0.871	--	--	--	--	--	--	--	--	--	--	--
	(d)	103.7	99.4	1.4	0.940	87.2	(e)	0.0	--	--	--	--	--	--	--	--
	[illegible]	104.2	99.9	1.1	0.944	74.6(f)	(e)	0 (f)	--	--	--	--	--	--	--	--
	(g)	106.0	100.3	2.1	0.948	69.5	(e)	0	--	--	--	--	--	--	--	--
	(g)	--	--	--	--	90.2	88.5	0.7	--	--	--	--	--	--	--	--
	Avg.	102.1	98.0	1.3	0.926	80.4	88.5	0.2	--	--	--	--	--	--	--	--
4	(g)	93.7	86.8	2.4(i)	0.820	82.1	79.9	0.2(i)	--	--	--	--	--	--	--	--
	(g)	--	--	--	--	8[illegible].3	81.0	1.7	--	--	--	--	--	--	--	--
	Avg.	93.7	86.8	2.4	0.820	82.7	80.4	1.0	--	--	--	--	--	--	--	--
10	Predicted	88	79	3	--	76	74	1	--	--	--	--	--	--	--	--
	(h)	--	--	--	--	74.5	(e)	0.2(i)	44.4	-40	46.8	-37	54 Da	-100	1 Da	-100
	(h)	--	--	--	--	74.4	(e)	0.4(i)	49.3	-34	42.7	-43	24 Da	-100	3 Da	-100
	Avg.	--	--	--	--	74.4	--	0.3	46.8	-37	44.8	-40	--	-100	--	-100
16	(g)	85.0	74.8	3.5	0.707	72.9	69.0	1.3	--	--	--	--	--	--	--	--
	(g)	--	--	--	--	71.5	69.4	0.3(i)	--	--	--	--	--	--	--	--
	Avg.	85.0	74.8	3.5	0.707	72.2	69.2	0.8	--	--	--	--	--	--	--	--
38	Predicted	78	65	4	--	65	62	1	--	--	--	--	--	--	--	--
	(h)	--	--	--	--	65.5	63.1	0.7	51.8	-21	48.9	-25	47.3	-28	14 Da	-100
	(h)	--	--	--	--	65.2	63.5	0.9	51.1	-22	50.9	-22	51.6	-21	34 Da	-100
	Avg.	--	--	--	--	65.4	63.3	0.8	51.4	-21	49.9	-24	49.4	-24	--	-100
40	(g)	77.6	65.0	4.1	0.614	65.0	61.2	0.9	--	--	--	--	--	--	--	--
	(g)	--	--	--	--	66.1	61.7	0.8(i)	--	--	--	--	--	--	--	--
	Avg.	77.6	65.0	4.1	0.614	65.6	61.4	0.8	--	--	--	--	--	--	--	--

Notes:
(a) Al, 10.6 Zn, 4.4 Mg, 2.0 Cu, 1.7 Mn 5 microns.
(b) SHT. 2 hrs. at 860°F, CWQ, Aged 24 hrs. at 250°F as 2 in. dia. piece.
(c) Table VII, Section II
(d) Table II Section III
(e) Failed before reaching 0.2% offset.
(f) Specimen contained discontinuity.
(g) Step Aging Data
(h) Stress Corrosion Data
(i) Failed at or outside gage marks.

Table XXXII

THE EFFECT OF STEP AGING ON TENSILE PROPERTIES AND STRESS CORROSION CRACKING RESISTANCE OF ALLOY 38 (a)

Age #2 (b)			Longitudinal				Transverse			Unstressed		Stressed 25% YS		Stressed 50% YS		Stressed 75% YS	
t	T	S. No.	TS ksi	YS ksi	El, % In 4D	YS/Density x10⁶ In.	TS ksi	YS ksi	El, % In 4D	TS ksi	% Change	TS, ksi or Days to Failure	% Change	TS, ksi or Days to Failure	% Change	Days to Failure	% Change
--	--	283453	108.4	104.9	1.6	0.990	95.5	95.1	0.6	--	--	--	--	--	--	--	--
			108.4	105.4	(c)	0.994	91.9	(d)	0	--	--	--	--	--	--	--	--
		Avg.	108.4	105.2	0.8	0.992	93.7	95.1	0.3	--	--	--	--	--	--	--	--
		283451	111.4	108.2	1.2	1.021	95.6	95.6	(d)	60.6	-37	17 Da	-100	2 Da	-100	1 Da	-100
			111.9	108.3	1.2	1.022	98.0	97.6	(d)	65.8	-32	6 Da	-100	1 Da	-100	1 Da	-100
		Avg.	111.6	108.2	1.2	1.021	96.8	96.6	(d)	63.2	-35	--	-100	--	-100	--	-100
2	330	283453	97.9	92.4	2.0	0.876	88.0	86.0	0.7	--	--	--	--	--	--	--	--
			96.9	92.7	2.2	0.875	89.4	86.6	0.6	--	--	--	--	--	--	--	--
		Avg.	97.4	92.6	2.1	0.875	88.7	86.3	0.6	--	--	--	--	--	--	--	--
4	330	283453	[illegible]	83.3	1.4	0.786	85.0	80.1	1.2	--	--	--	--	--	--	--	--
			91.[illegible]	84.3	3.0	0.795	84.1	79.7	0.8	--	--	--	--	--	--	--	--
		Avg.	89.6	83.8	2.2	0.791	84.6	79.9	1.0	--	--	--	--	--	--	--	--
8	330	283453	87.4	80.3	2.5	0.755	82.1	76.4	2.0	--	--	--	--	--	--	--	--
			87.5	80.1	3.3	0.756	79.7	75.2	1.3	--	--	--	--	--	--	--	--
		Avg.	87.4	80.2	2.9	0.757	80.9	75.8	1.6	--	--	--	--	--	--	--	--
16	330	283453	81.5	72.3	5.0	0.682	74.4	69.5	1.6	--	--	--	--	--	--	--	--
			81.9	72.3	4.0	0.682	76.6	70.1	1.9	--	--	--	--	--	--	--	--
		Avg.	81.7	72.3	4.5	0.682	75.5	69.8	1.8	--	--	--	--	--	--	--	--
24	330	283453	81.5	69.9	4.0	0.659	75.9	65.2	3.1	66.0	-13	66.0	-13	66.5	-12	26 Da	-100
			--	--	--	--	75.2	65.6	2.8	65.2	-14	67.3	-11	65.7	-13	84 Da	-100
		Avg.	81.5	69.9	4.0	0.659	75.6	65.4	3.0	65.6	-13	66.6	-12	66.1	-13	--	-100
32	330	283453	76.4	62.6	5.0	0.591	70.9	63.1	2.4	--	--	--	--	--	--	--	--
			76.1	64.4	5.0	0.606	70.1	63.0	1.8	--	--	--	--	--	--	--	--
		Avg.	76.2	63.5	5.0	0.599	70.5	63.0	2.1	--	--	--	--	--	--	--	--
48	330	283453	73.2	61.4	5.0	0.579	69.3	59.4	3.1	--	--	--	--	--	--	--	--
			73.2	60.9	6.0	0.575	68.9	59.4	2.8	--	--	--	--	--	--	--	--
		Avg.	73.2	61.2	5.5	0.577	69.1	59.4	3.0	--	--	--	--	--	--	--	--
1	350	283453	93.3	87.3	2.4	0.824	--	--	--	--	--	--	--	--	--	--	--
			92.6	86.8	2.6	0.819	--	--	--	--	--	--	--	--	--	--	--
		Avg.	93.0	87.0	2.5	0.821	--	--	--	--	--	--	--	--	--	--	--
2	350	283453	88.4	82.3	1.8	0.776	--	--	--	--	--	--	--	--	--	--	--
			88.1	80.9	3.2	0.763	--	--	--	--	--	--	--	--	--	--	--
		Avg.	88.2	81.6	2.5	0.770	--	--	--	--	--	--	--	--	--	--	--
4	350	283453	[illegible]	75.2	4.0	0.709	--	--	--	--	--	--	--	--	--	--	--
			83.6	75.2	4.0	0.709	--	--	--	--	--	--	--	--	--	--	--
		Avg.	83.5	75.2	4.0	0.709	--	--	--	--	--	--	--	--	--	--	--
	350	283453	76.7	68.2	4.0	0.643	--	--	--	--	--	--	--	--	--	--	--
			78.7	67.7	5.0	0.639	--	--	--	--	--	--	--	--	--	--	--
		Avg.	78.7	68.0	4.5	0.642	--	--	--	--	--	--	--	--	--	--	--
12	350	283453	76.1	64.2	5.0	0.606	--	--	--	--	--	--	--	--	--	--	--
			75.9	64.2	6.0	0.606	--	--	--	--	--	--	--	--	--	--	--
		Avg.	76.0	64.2	5.5	0.606	--	--	--	--	--	--	--	--	--	--	--

(a) Al, 8.5 Zn, 3.5 Mg, 1.1 Mn, 1.2 Fe, 3.0 Ni.
(b) All specimens SHT 2 hrs. at 860°F, CWQ, Age #1 24 hrs. at 250°F.
(c) Not obtained, specimen shattered.
(d) Failed before reaching 0.2% offset.

Table XXXIII

THE EFFECT OF STEP AGING ON TENSILE PROPERTIES OF ALLOYS 39, 49 AND 50

Age #2 (d)		Alloy 39 S. No. 283460 (a)				Alloy 49 S. No. 283471 (b)				Alloy 50 S. No. 283480 (c)			
t	T	T.S. ksi	Y.S. ksi	El, % in 4D	Y.S./Density x 10^6 in	T.S. ksi	Y.S. ksi	El, % in 4D	Y.S./Density x 10^6 in	T.S. ksi	Y.S. ksi	El, % in 4D	Y.S./Density x 10^6 in
--	---	106.9	103.5	1.3	0.975	106.4	102.5	1.1	0.932	98.4	97.0	1.4	0.908
	---	97.0(e)	(f)	0(e)	-----	107.9	104.9	1.0	0.954	101.7	96.0	1.6	0.899
	Avg.	106.9	103.5	1.3	0.975	107.2	103.7	1.0	0.943	100.0	96.5	1.5	0.904
16	330	81.8	72.6	2.3	0.684	81.2	76.0	1.6	0.691	85.0	76.7	1.7	0.718
		79.5	68.8	1.4	0.648	81.6	78.0	2.6	0.709	84.3	77.6	1.5	0.727
	Avg.	80.6	70.7	1.8	0.666	81.4	77.0	2.1	0.700	84.6	77.2	1.6	0.723
32	330	68.2	58.2	2.9	0.549	74.1	67.3	3.1	0.612	79.0	70.5	2.7	0.660
		77.1	65.3	1.7	0.615	75.2	66.4	3.0	0.604	77.2	69.7	2.1	0.653
	Avg.	72.6	61.8	2.3	0.582	74.6	66.8	3.0	0.608	78.1	70.1	2.4	0.656
48	330	73.9	60.8	4.4	0.573	72.3	62.7	2.7	0.570	72.1	66.2	1.3	0.620
		73.4	60.7	3.5	0.572	71.8	63.4	3.3	0.576	76.5	66.0	2.7	0.618
	Avg.	73.6	60.8	4.0	0.573	72.0	63.0	3.0	0.573	74.3	66.1	2.0	0.619
4	350	84.3	75.7	2.4	0.713	83.9	77.7	1.7	0.706	84.7	78.3	1.8	0.733
		79.0	74.9	1.1	0.706	83.4	78.7	1.3	0.715	84.7	78.9	2.0	0.739
	Avg.	81.6	75.3	1.8	0.710	83.6	78.2	1.5	0.711	84.7	78.6	1.9	0.736
8	350	78.3	67.2	2.8	0.633	77.1	70.6	2.5	0.642	80.5	73.0	2.5	0.683
		80.2	69.3	3.1	0.653	65.0	60.8	0.3	0.553	80.0	72.3	2.2	0.677
	Avg.	79.2	68.2	3.0	0.643	71.0	65.7	1.4	0.597	80.2	72.6	2.4	0.680
12	350	77.2	64.7	3.4	0.615	73.5	65.8	3.2	0.599	77.9	69.2	2.8	0.648
		77.4	65.3	3.6	0.610	69.2	66.0	1.5	0.600	78.2	68.8	2.1	0.644
	Avg.	77.3	65.0	3.5	0.612	71.4	65.9	2.4	0.599	78.0	69.0	2.4	0.646

NOTE:
(a) Al, 10.9 Zn, 4.9 Mg, 2.0 Cu, 1.8 Mn
(b) Al, 15.3 Zn, 4.6 Mg, 2.0 Cu, 1.9 Mn
(c) Al, 10.0 Zn, 4.1 Mg, 0.9 Cu, 1.4 Mn, 1.1 Fe, 1.4 Ni, 0.01 Cr, 0.02 Ti
(d) All specimens SHT 2 hrs @ 860°F, CWQ, Age #1 24 hrs @ 250°F
(e) Not included in average
(f) Failed before reaching 0.2% offset

Table XXXIV

THE EFFECT OF STEP AGING ON TENSILE PROPERTIES AND STRESS CORROSION CRACKING RESISTANCE OF ALLOY 52 (a)

Age #2 (b)			Longitudinal				Transverse			Unstressed		Stressed 25% YS		Stressed 50% YS		Stressed 75% YS	
t	T	S. No.	TS ksi	YS ksi	El, % In 4D	YS/Density x10⁶ In.	TS ksi	YS ksi	El, % In 4D	TS ksi	% Change	TS ksi	% Change	TS ksi or Days to Failure	% Change	TS ksi or Days to Failure	% Change
--	--	283496	107.7	105.7	2.7	1.010	92.4	89.0	1.1	--	--	--	--	--	--	--	--
			106.5	104.0	2.4	0.993	90.2	(c)	0	--	--	--	--	--	--	--	--
		Avg.	107.1	104.8	2.6	1.001	91.3	89.0	0.6	--	--	--	--	--	--	--	--
		283496	108.6	105.2	2.6	1.005	89.8	89.6	(d)	49.8	-45	64.8	-28	12 Ds	-100	6 Ds	-100
			[illegible]	[illegible]	[illegible]	1.012	89.8	89.8	(d)	65.6	-27	65.9	-27	15 Ds	-100	5 Ds	-100
		Avg.	109.4	105.6	2.9	1.008	89.8	89.6	--	57.7	-36	65.4	-27	--	-100	--	-100
2	330	283496	94.6	93.0	1.9	0.888	88.5	84.1	1.5	--	--	--	--	--	--	--	--
			--	--	--	--	88.5	83.8	1.5	--	--	--	--	--	--	--	--
		Avg.	94.6	93.0	1.9	0.888	88.5	84.0	1.5	--	--	--	--	--	--	--	--
4	330	283496	94.8	[illegible]	5.0	0.860	85.8	81.3	1.9	--	--	--	--	--	--	--	--
			94.2	89.6	3.5	0.858	83.7	79.7	1.1	--	--	--	--	--	--	--	--
		Avg.	94.5	89.9	4.2	0.859	84.8	80.5	1.5	--	--	--	--	--	--	--	--
		283496	93.5	88.6	4.4	0.846	83.5	79.6	1.3	72.3	-13	74.4	-11	71.2	-15	33 Ds	-100
			--	--	--	--	83.6	79.7	1.6	66.7	-20	70.8	-15	69.8	-17	25 Ds	-100
		Avg.	93.5	88.6	4.4	0.846	83.6	79.6	1.4	69.5	-17	72.6	-13	70.5	-16	--	-100
8	330	283496	89.9	[illegible]	6.0	0.796	71.9	(c)	0	--	--	--	--	--	--	--	--
			90.4	83.7	7.0	0.799	78.9	76.7	1.3	--	--	--	--	--	--	--	--
		Avg.	91.2	83.5	6.5	0.798	75.4	76.7	0.6	--	--	--	--	--	--	--	--
16	330	283496	83.6	76.2	7.0	0.728	78.9	70.6	3.7	--	--	--	--	--	--	--	--
			83.5	75.6	6.0	0.722	73.4	69.1	1.7	--	--	--	--	--	--	--	--
		Avg.	83.6	75.9	6.5	0.725	76.2	69.8	2.7	--	--	--	--	--	--	--	--
24	330	283496	79.3	69.6	6.0	0.665	72.2	62.8	3.4	63.0	-12	63.0	-12	63.2	-11	63.3	-11
			--	--	--	--	70.7	63.8	2.5	62.6	-12	62.8	-12	61.6	-14	62.6	-12
		Avg.	79.3	69.6	6.0	0.665	71.4	63.3	3.0	62.8	-12	62.9	-12	62.4	-13	63.0	-12
32	330	283496	76.8	67.9	6.0	0.649	73.0	62.3	4.3	--	--	--	--	--	--	--	--
			76.7	67.1	6.0	0.641	73.6	63.6	2.9	--	--	--	--	--	--	--	--
		Avg.	76.8	67.5	6.0	0.645	73.3	63.0	3.6	--	--	--	--	--	--	--	--
48	330	283496	73.4	61.5	8.0	0.587	70.1	56.6	5.1	--	--	--	--	--	--	--	--
			73.4	63.3	6.0	0.605	68.0	57.8	2.7	--	--	--	--	--	--	--	--
		Avg.	73.4	62.4	7.0	0.596	69.0	58.2	3.9	--	--	--	--	--	--	--	--
1	350	283496	95.0	90.9	6.0	0.868	--	--	--	--	--	--	--	--	--	--	--
			95.0	89.5	3.9	0.855	--	--	--	--	--	--	--	--	--	--	--
		Avg.	95.0	90.2	5.0	0.862	--	--	--	--	--	--	--	--	--	--	--
2	350	283496	90.9	85.4	5.0	0.816	--	--	--	--	--	--	--	--	--	--	--
			90.6	85.2	5.0	0.814	--	--	--	--	--	--	--	--	--	--	--
		Avg.	90.8	85.3	5.0	0.815	--	--	--	--	--	--	--	--	--	--	--
4	350	283496	85.0	77.2	6.0	0.737	--	--	--	--	--	--	--	--	--	--	--
			85.0	77.2	7.0	0.737	--	--	--	--	--	--	--	--	--	--	--
		Avg.	85.0	77.2	6.5	0.737	--	--	--	--	--	--	--	--	--	--	--
8	350	283496	79.5	75.3	8.0	0.671	--	--	--	--	--	--	--	--	--	--	--
			80.2	75.3	8.0	0.671	--	--	--	--	--	--	--	--	--	--	--
		Avg.	79.8	75.3	8.0	0.671	--	--	--	--	--	--	--	--	--	--	--
12	350	283496	76.9	66.1	8.0	0.631	--	--	--	--	--	--	--	--	--	--	--
			76.7	66.4	8.0	0.634	--	--	--	--	--	--	--	--	--	--	--
		Avg.	76.8	66.2	8.0	0.632	--	--	--	--	--	--	--	--	--	--	--

a) Al, [illegible] Zn, 4.0 Mg, 0.9 Cu, 0.01 Cr, 0.02 Ti, 1.5 Co.
b) All specimens SHT 2 hrs at 860°F, CWQ, Age #1 24 hrs. at 250°F.
c) Failed before reaching 0.2% offset.
d) Specimen failed at approx. 0.2% offset.

Table XXXV

THE EFFECT OF STEP AGING ON TENSILE PROPERTIES OF ALLOY 59, S. No. 277934 (a)

Additional Aging Time At 330°F-Hrs. (6)	Data Source	Longitudinal T.S. ksi	Longitudinal Y.S. ksi	Longitudinal EL, % in 4D	Longitudinal Y.S./Density x 10⁶ in.	Transverse T.S. ksi	Transverse Y.S. ksi	Transverse EL, % in 4D
0	(c)	90.9	(d)	0.4	-	-	-	-
	(e)	96.2	(f)	0.0	-	73.8 (g)	(d)	0 (g)
	(e)	89.7	(f)	0.0	-	50.1	(d)	0 (g)
	(h)	84.4	(d)	0.0	-	70.8	(d)	0
	(h)	90.5	(d)	0.0	-	63.5	(d)	0
	Avg.	90.3	-	0.0	-	64.6	-	0
4	(h)	90.2	89.8	0.5 (i)	0.829	52.2	(d)	0
	(h)	91.8	90.1	0.5 (i)	0.832	62.3	(d)	0
	Avg.	91.0	90.0	0.5	0.831	57.2	-	0
16	(h)	83.4	78.4	1.2 (i)	0.724	67.9	(d)	0
	(h)	82.7	78.9	1.0	0.729	64.2	(d)	0
	Avg.	83.0	78.6	1.1	0.726	66.0	-	0
40	(h)	76.5	71.3	1.3 (i)	0.658	63.4	(d)	0
	(h)	74.1	69.0	0.6 (i)	0.637	60.4	(d)	0
	Avg.	75.3	70.2	1.0	0.648	61.9	-	0

(a) Al, 10.2 Zn, 3.9 Mg, 1.6 Cu, 1.6 Mn, 1.0 Fe, 4.1 Ni, 15 Microns
(b) SHT 2 Hrs, at 860°F. CWQ, Age #1 24 Hrs at 250°F. as 2 in. Dia. Piece
(c) Table VII, Section I
(d) Failed before reaching 0.2% offset
(e) Table VIII, Section II
(f) Strain follower not used to avoid breaking it
(g) Specimen contains discontinuity
(h) Step aging data
(i) Specimen failed at or outside gage mark

TABLE XXXVI

THE EFFECT OF STEP AGING ON TENSILE PROPERTIES AND STRESS CORROSION CRACKING RESISTANCE OF ALLOY 59

S.NO. 277935 (a)

Additional Aging Time at 330°F Hrs.(b)	Data Source	Longitudinal				Transverse			Unstressed		Stressed 25% TS		Stressed 50% TS		Stressed 75% TS	
		TS ksi	YS ksi	El, % In 4D	YS/Density x10⁶ In.	TS ksi	YS ksi	El, % In 4D	TS ksi	% Change	TS ksi	% Change	TS, ksi or Days to Failure	% Change	TS, ksi or Days to Failure	% Change
0	(c)	90.4	(d)	0.4	--	--	--	--	--	--	--	--	--	--	--	--
	(e)	67.3(f)	(g)	0 (f)	--	73.0(f)	(g)	0 (f)	--	--	--	--	--	--	--	--
	(e)	106.1	102.9	1.0	0.950	93.5	(g)	0.0	--	--	--	--	--	--	--	--
	(h)	108.1	102.9	(i)	0.950	93.4	(g)	0	--	--	--	--	--	--	--	--
	(h)	--	--	--	--	79.9	(g)	0	--	--	--	--	--	--	--	--
	Avg.	101.5	102.9	0.3	0.950	85.0	--	0	--	--	--	--	--	--	--	--
4	(h)	95.1	89.6	1.0	0.827	69.2	(d)	0	--	--	--	--	--	--	--	--
	(h)	--	--	--	--	85.9	85.9	0.4(k)	--	--	--	--	--	--	--	--
	Avg.	95.1	89.6	1.0	0.827	77.6	85.9	02.	--	--	--	--	--	--	--	--
16	(h)	94.6	76.1	1.1(k)	0.703	77.7	74.0	0.3(k)	--	--	--	--	--	--	--	--
	(h)	--	--	--	--	76.3	74.2	0.4	--	--	--	--	--	--	--	--
	Avg.	84.6	76.1	1.1	0.703	77.0	74.1	0.4	--	--	--	--	--	--	--	--
40	(h)	82.6	68.0	1.9(k)	0.628	70.9	65.2	0.8(k)	--	--	--	--	--	--	--	--
	(h)	--	--	--	--	71.[illegible]	65.4	0.5(k)	--	--	--	--	--	--	--	--
	(j)	--	--	--	--	74.1	68.3	1.5	58.6	-22	58.4	-22	58.5	-22	6 Da	-100
	(j)	--	--	--	--	75.5	69.0	0.7(k)	58.9	-21	58.1	-22	60.2	-20	58.0	-22
	Avg.	82.6	68.0	1.9	0.628	73.0	67.0	0.9	58.8	-21	58.2	-22	59.4	-21	--	-61

Notes:
(a) Al 10.2 Zn, 3.9 Mg, 1.6 Cu, 1.6 Mn, 1.0 Fe, 4.1 Ni 6 microns APD
(b) S.H.T. 2 hrs. at 860°F, CWQ, Age #1 24 hrs. at 250°F as 2 in. dia. piece.
(c) Table VII Section II
(d) Failed before reaching 0.2% Offset.
(e) Table II Section III
(f) Specimen contained discontinuity.
(g) Strain follower not used to avoid breaking it.
(h) Step Aging Data.
(i) Not determined - specimen shattered.
(j) Stress corrosion data.
(k) Specimen failed at or outside gage marks.

Table XXXVII

THE EFFECT OF STEP AGING ON TENSILE PROPERTIES AND STRESS CORROSION CRACKING RESISTANCE OF ALLOY 60

S. No. 283758 (a)

Additional Aging Time at 330°F-Hrs. (b)	Data Source	Longitudinal TS ksi	Longitudinal YS ksi	Longitudinal El, % In 4D	Longitudinal YS/Density x10⁶ In.	Transverse TS ksi	Transverse YS ksi	Transverse El, % In 4D	Unstressed TS ksi	Unstressed % Change	Stressed 25% TS TS ksi	Stressed 25% TS % Change	Stressed 50% TS TS ksi	Stressed 50% TS % Change	Stressed 75% TS Days to Failure	Stressed 75% TS % Change
0	(c)	106.3	104.2	1.9	0.993	84.8	84.8	0.4(f)	--	--	--	--	--	--	--	--
	(c)	--	--	--	--	79.9	(e)	0	--	--	--	--	--	--	--	--
	Avg.	106.3	104.2	1.9	0.993	82.4	84.8	0.2	--	--	--	--	--	--	--	--
4	(c)	95.9	93.7	2.3	0.893	77.4	(e)	0	--	--	--	--	--	--	--	--
	(c)	--	--	--	--	80.2	(e)	0	--	--	--	--	--	--	--	--
	Avg.	95.9	93.7	2.3	0.893	78.8	--	0	--	--	--	--	--	--	--	--
16	(c)	82.8	80.3	2.2	0.765	62.6	(e)	0	--	--	--	--	--	--	--	--
	(c)	--	--	--	--	69.9	(e)	0	--	--	--	--	--	--	--	--
	Avg.	82.8	80.3	2.2	0.765	66.2	--	0	--	--	--	--	--	--	--	--
40	(c)	74.8	70.7	5.2	0.674	68.1	64.6	0.8	--	--	--	--	--	--	--	--
	(c)	--	--	--	--	66.4	64.2	0.3(f)	--	--	--	--	--	--	--	--
	(d)	--	--	--	--	68.4	65.3	0.6	46.5	-32	40.8	-41	50.1	-27	6 Da	-100
	(d)	--	--	--	--	68.9	65.6	0.9	43.4	-37	47.3	-31	40.4	-41	5 Da	-100
	Avg.	74.8	70.7	5.2	0.674	68.0	64.9	0.6	45.0	-35	44.0	-36	45.2	-34	--	-100

Notes: (a) Al, 11.6 Zn, 5.5 Mg, 1.8 Cu, 0.7 Mn.

(b) SHT 2 hrs. at 860°F, CWQ, Age #1 24 hrs. at 250°F as 2 in. dia. piece.

(c) Step Aging Data.

(d) Stress Corrosion Data.

(e) Failed before reaching 0.2% offset.

(f) Specimen failed at or outside gage mark.

Table XXXVIII

THE EFFECT OF STEP AGING ON TENSILE PROPERTIES AND STRESS CORROSION CRACKING RESISTANCE OF ALLOY 61

S. No. 283759 (a)

Additional Aging Time at 330°F, Hrs (b)	Data Source	Longitudinal T.S. ksi	Longitudinal Y.S. ksi	Longitudinal El, % in 4D	Longitudinal Y.S./Density x 10⁶ in	Transverse T.S. ksi	Transverse Y.S. ksi	Transverse El, % in 4D	Unstressed T.S. ksi	Unstressed % Change	Stressed 25% T.S. T.S. ksi	Stressed 25% T.S. % Change	Stressed 50% T.S. T.S., ksi, or Days to Failure	Stressed 50% T.S. % Change	Stressed 75% T.S. Days to Failure	Stressed 75% T.S. % Change
0	(c)	109.1	106.3	3.0	1.030	91.1	87.2	0.9	----	----	----	----	-------	----	-------	----
	(c)	108.9	106.3	3.4	1.030	91.6	87.7	(e)	----	----	----	----	-------	----	-------	----
	Avg.	109.0	106.3	3.2	1.030	91.4	87.4	0.9	----	----	----	----	-------	----	-------	----
4	(c)	93.9	91.3	5.5	0.885	80.5	80.1	0.1(f)	----	----	----	----	-------	----	-------	----
	(c)	94.4	91.6	5.5	0.888	83.1	80.4	1.1	----	----	----	----	-------	----	-------	----
	Avg.	94.2	91.4	5.5	0.886	81.8	80.2	0.6	----	----	----	----	-------	----	-------	----
8	Predicted	88	83	7	-----	78	74	1	----	----	----	----	-------	----	-------	----
	(d)	----	----	----	-----	81.5	75.2	1.1(f)	59.4	-27	50.9	-38	35 days	-100	7 days	-100
	(d)	----	----	----	-----	81.7	77.2	0.8(f)	64.0	-22	48.5	-41	21 days	-100	6 days	-100
	Avg.	----	----	----	-----	81.6	76.2	1.0	61.7	-24	49.7	-39	-----	-100	-----	-100
16	(c)	82.6	76.6	9.0	0.742	74.0	68.4	2.0	----	----	----	----	-------	----	-------	----
	(c)	83.0	77.0	7.5	0.746	73.8	68.4	1.4(f)	----	----	----	----	-------	----	-------	----
	Avg.	82.8	76.8	8.2	0.744	73.9	68.4	1.7	----	----	----	----	-------	----	-------	----
22	Predicted	80	72	9	-----	71	65	2	----	----	----	----	-------	----	-------	----
	(d)	----	----	----	-----	70.7	68.3	0.7	62.9	-14	56.0	-23	58.7	-19	35 days	-100
	(d)	----	----	----	-----	74.9	68.3	2.7	62.4	-14	60.6	-17	56.4	-23	24 days	-100
	Avg.	----	----	----	-----	72.8	68.3	1.7	62.6	-14	58.3	-20	57.6	-21	-----	-100
30	Predicted	77	69	10	-----	69	62	2								
	(d)	----	-----	----	-----	71.1	64.6	2.4	60.5	-15	54.4	-23	49.6	-30	35 days	-100
	(d)	----	-----	----	-----	71.0	64.9	2.3	60.8	-14	57.3	-19	49.3	-31	24 days	-100
	Avg.	----	-----	----	-----	71.0	64.8	2.4	60.6	-15	55.8	-21	49.4	-30	-----	-100
40	(c)	74.1	65.5	10.0	0.635	69.0	59.5	4.3	----	----	----	----	-------	----	-------	----
	(c)	74.3	65.5	11.0	0.635	63.0	59.5	1.4	----	----	----	----	-------	----	-------	----
	Avg.	74.2	65.5	10.5	0.635	66.0	59.5	2.8	----	----	----	----	-------	----	-------	----

NOTE: (a) Al, 10.4 Zn, 4.5 Mg, 0.8 Cu
(b) SHT 2 hrs at 860°F, CWQ, Age #1 24 hrs at 250°F
(c) Step aging data
(d) Stress corrosion data
(e) Not determined, specimen shattered
(f) Specimen failed at or outside gage length

Table XXXIX

THE EFFECT OF STEP AGING ON TENSILE PROPERTIES AND STRESS CORROSION CRACKING RESISTANCE OF ALLOY 71

S. No. 293387

Age #2 (b)		Longitudinal				Transverse			Unstressed		Stressed 25% YS		Stressed 50% YS		Stressed 75% YS	
t	T	TS ksi	YS ksi	El, % In 4D	YS/Density x10⁶ In.	TS ksi	YS ksi	El, % In 4D	TS ksi	% Change	TS ksi	% Change	TS ksi or Days to Failure	% Change	TS, ksi or Days to Failure	% Change
--	--	109.0	103.9	4.0	1.005	93.2	89.0	2.0	--	--	--	--	--	--	--	--
		107.1	102.9	5.0	0.995	94.0	89.0	1.0	--	--	--	--	--	--	--	--
	Avg.	108.0	103.4	4.5	1.000	93.6	89.0	1.5	--	--	--	--	--	--	--	--
		107.7	105.0	4.8	1.015	92.0	87.8	1.0	58.1	-37	53.5	-42	18 Da	-100	13 Da	-100
		--	--	--	--	65.6(e)	(e)	(e)	61.9	-33	69.3	-25	22 Da	-100	7 Da	-100
	Avg.	107.7	105.0	4.6	1.015	92.0	87.8	1.0	60.0	-35	61.4	-33	--	-100	--	-100
2	300	103.2	100.3	4.5	0.970	91.9	87.1	1.0	--	--	--	--	--	--	--	--
		102.2	99.8	6.0	0.965	87.8	85.5	1.0	--	--	--	--	--	--	--	--
	Avg.	102.8	100.0	5.2	0.967	89.8	86.3	1.0	--	--	--	--	--	--	--	--
4	300	101.2	98.3	5.5	0.951	88.6	85.6	1.0	--	--	--	--	--	--	--	--
		101.4	97.8	6.0	0.946	90.3	85.4	2.0	--	--	--	--	--	--	--	--
	Avg.	101.3	98.0	5.8	0.948	89.4	85.5	1.5	--	--	--	--	--	--	--	--
8	300	99.3	95.2	6.5	0.921	87.7	84.0	1.0	--	--	--	--	--	--	--	--
		98.4	94.0	6.5	0.909	85.8	83.3	1.0	--	--	--	--	--	--	--	--
	Avg.	98.8	94.6	6.5	0.915	86.8	83.6	1.0	--	--	--	--	--	--	--	--
24	300	91.4	86.2	8.0	0.834	80.2	77.2	1.0	--	--	--	--	--	--	--	--
		91.0	85.9	7.5	0.831	85.3	77.7	5.0	--	--	--	--	--	--	--	--
	Avg.	91.2	86.0	7.8	0.832	82.8	77.4	3.0	--	--	--	--	--	--	--	--
48	300	85.5	79.2	9.0	0.766	79.9	72.1	5.0	--	--	--	--	--	--	--	--
		85.5	79.2	9.5	0.766	79.8	72.5	4.0	--	--	--	--	--	--	--	--
	Avg.	85.5	79.2	9.2	0.766	79.8	72.3	4.5	--	--	--	--	--	--	--	--
2	330	97.1	93.4	7.0	0.903	86.4	82.1	2.0	--	--	--	--	--	--	--	--
		96.1	92.2	5.0	0.892	81.7	(c)	0.0	--	--	--	--	--	--	--	--
	Avg.	96.6	92.8	6.0	0.898	84.0	82.1	1.0	--	--	--	--	--	--	--	--
3	330	93.5	88.1	7.0	0.852	82.5	79.9	2.0	76.0	-10	75.2	-11	60.3	-28	31 Da	-100
		--	--	--	--	85.5	79.0	4.0	76.6	-9	68.4	-19	41.7	-50	31 Da	-100
	Avg.	93.5	88.1	7.0	0.852	84.0	79.4	3.0	76.3	-9	71.8	-15	51.0	-39	--	-100
4	330	92.9	88.6	8.0	0.857	83.1	79.9	1.0	--	--	--	--	--	--	--	--
		92.5	87.7	8.0	0.848	83.9	79.5	(d)	--	--	--	--	--	--	--	--
	Avg.	92.7	88.2	8.0	0.853	83.5	79.7	1.0	--	--	--	--	--	--	--	--
8	330	87.3	81.3	9.0	0.786	80.2	73.4	4.0	--	--	--	--	--	--	--	--
		86.9	80.8	9.5	0.781	79.1	73.8	4.0	--	--	--	--	--	--	--	--
	Avg.	87.1	81.0	9.2	0.783	79.6	73.6	4.0	--	--	--	--	--	--	--	--
		87.2	80.1	8.9	0.775	76.6	72.0	2.0	71.3	-8	71.3	-8	70.7	-8	45 Da	-100
		--	--	--	--	77.3	71.1	4.0	71.4	-7	71.8	-7	69.7	-10	54 Da	-100
	Avg.	87.2	80.1	8.9	0.775	77.0	71.6	3.0	71.4	-7	71.6	-7	70.2	-9	--	-100
16	330	82.2	74.6	9.0	0.721	76.7	67.5	5.0	--	--	--	--	--	--	--	--
		81.7	73.8	10.0	0.714	73.4	67.6	3.0	--	--	--	--	--	--	--	--
	Avg.	82.0	74.2	9.5	0.718	75.0	67.6	4.0	--	--	--	--	--	--	--	--
20	330	80.9	71.1	7.8	0.688	75.5	63.5	8.0	65.7	-12	66.4	-11	65.2	-13	56.2	-25
		--	--	--	--	73.6	63.8	5.0	66.7	-11	66.3	-11	65.0	-13	55.8	-25
	Avg.	80.9	71.1	7.8	0.688	74.6	63.6	6.5	66.2	-11	66.4	-11	65.1	-13	56.0	-25
32	330	76.4	66.7	11.0	0.645	68.9	61.0	4.0	--	--	--	--	--	--	--	--
		75.8	65.7	11.5	0.635	72.1	61.5	6.0	--	--	--	--	--	--	--	--
	Avg.	76.1	66.2	11.2	0.640	70.5	61.2	5.0	--	--	--	--	--	--	--	--
48	330	72.8	62.1	12.0	0.601	70.9	57.8	8.0	--	--	--	--	--	--	--	--
		72.7	62.1	11.0	0.601	70.5	57.8	8.0	--	--	--	--	--	--	--	--
	Avg	72.8	62.1	11.5	0.601	70.7	57.8	8.0	--	--	--	--	--	--	--	--

(a) Al, 9.3 Zn, 3.6 Mg, 0.5 Cu, 0.02 Cr, 0.02 Ti, 0.7 Co.
(b) All specimens SHT 2 hrs. at 860°F, CWQ, Age #1 24 hrs. at 250°F.
(c) Failed before reaching 0.2% offset.
(d) Not obtained, specimen shattered.
(e) Premature failure - Disregard

Table XL

THE EFFECT OF PROLONGED AGING AND QUENCHING RATES ON TENSILE PROPERTIES AND STRESS CORROSION CRACKING OF ALLOY 34 (a)

Quench	Age (a) t	Age (a) T	S. No.	Longitudinal TS ksi	Longitudinal YS ksi	Longitudinal El, % In 4D	Longitudinal YS/Density x 10^6 In.	Transverse TS ksi	Transverse YS ksi	Transverse El, % In 4D	Stress Value Used	Unstressed TS ksi	Unstressed % Change	Stressed 25% TS ksi	Stressed 25% % Change	Stressed 50% TS, ksi or Days to Failure	Stressed 50% % Change	Stressed 75% TS, ksi or Days to Failure	Stressed 75% % Change
CWQ	24	250	283441	97.1(f)	(b)(f)	0(f)	-(f)	101.9	(b)	(d)	--	50.4(h)	-50(h)	54.8(h)	-46(h)	1 Da	-100	--	--
CWQ	24	250		106.1(f)	101.9(f)	0.7(f)	0.928(f)	100.6	(b)	(d)	--	55.4(h)	-45(h)	52.6(h)	-48(h)	1 Da	-100	--	--
CWQ	24	250		--	--	--	--	--	--	--	--	--	--	42.7(h)	-58(h)	1 Da	-100	--	--
CWQ	24	250	Avg.	101.6(f)	101.9(f)	0.4(f)	0.928(f)	101.2	--	--	101.2	52.9(h)	-48(h)	50.0(h)	-51(h)	--	-100	--	--
CWQ	24	250	283444	104.4(g)	102.5(g)	0.7(g)	0.941(g)	99.4	(b)	(d)	--	57.5	-43	69.5	-31	2 Da	-100	1 Da	-100
CWQ	24	250		106.6(g)	106.5(g)	0.7(g)	0.977(g)	101.3	(b)	(d)	--	67.3	-33	66.2	-34	2 Da	-100	1 Da	-100
CWQ	24	250	Avg.	105.5(g)	104.5(g)	0.7(g)	0.959(g)	100.4	--	--	100.4	62.4	-38	67.8	-32	--	-100	--	-100
CWQ	24	250	283441	--	--	--	--	98.8	(b)	(d)	--	51.1	-49	53.2	-46	2 Da	-100	1 Da	-100
CWQ	24	250		--	--	--	--	100.2	(b)	(d)	--	24.6	-75	57.8	-42	1 Da	-100	1 Da	-100
CWQ	24	250	Avg.	--	--	--	--	99.5	--	--	99.5	37.8	-62	55.0	-44	--	-100	--	-100
CWQ	24	250	283443	--	--	--	--	103.1	(b)	(d)	--	75.2	-22	62.2	-36	1 Da	-100	2 Da	-100
CWQ	24	250		--	--	--	--	90.8	(b)	(d)	--	57.0	-41	63.3	-35	3 Da	-100	2 Da	-100
CWQ	24	250		--	--	--	--	--	--	--	--	--	--	--	--	--	--	1 Da	-100
CWQ	24	250	Avg.	--	--	--	--	97.0	--	--	97.0	66.1	-32	62.8	-35	--	-100	--	-100
CWQ	24	250	283440	--	--	--	--	84.2	(b)	(d)	--	50.0	-41	57.7	-31	2 Da	-100	1 Da	-100
CWQ	24	250		--	--	--	--	84.1	(b)	(d)	--	51.2	-39	60.5	-28	2 Da	-100	2 Da	-100
CWQ	24	250	Avg.	--	--	--	--	84.2	--	--	84.2	50.6	-40	59.1	-30	--	-100	--	-100
CWQ	24	250	Overall Avg.	103.6(c)	103.6(c)	0.5(c)	0.949	96.4	--	--	--	54.2	-43	61.7	-35	--	-100	--	-100
CWQ	8	330	283443	--	--	--	--	88.3	(b)	(d)	--	65.6	-27	77.8	-13	74.8	-16	3 Da	-100
CWQ	8	330		--	--	--	--	90.4	89.3	0.4	--	70.2	-10	74.4	-17	71.5	-20	3 Da	-100
CWQ	8	330	Avg.	--	--	--	--	89.4	--	--	89.4	72.9	-18	76.1	-15	73.2	-18	--	-100
CWQ	6/250+8/330		283444	88.7(f)	83.2(f)	0.7(f)	0.758(f)	91.6	88.5	1.3	--	77.2	-14	74.6	-17	74.6	-17	61 Da	-100
CWQ	6/250+8/330			87.9(f)	82.2(f)	0.7(f)	0.749(f)	88.4	87.4	0.7	--	66.0	-27	80.1	-11	66.5	-26	31 Da	-100
CWQ	6/250+8/330		Avg.	88.3(f)	82.7(f)	0.7(f)	0.753(f)	90.0	88.0	1.0	90.0	71.6	-20	77.4	-14	70.6	-22	--	-100
CWQ	6/250+8/330		283448	--	--	--	--	85.5	82.0	0.7	--	67.6	-22	69.5	-19	63.5	-26	59.5	-31
CWQ	6/250+8/330			--	--	--	--	87.0	82.1	0.9	--	63.6	-26	64.6	-25	67.5	-22	55.9	-35
CWQ	6/250+8/330		Avg.	--	--	--	--	86.2	82.0	0.8	82.0	65.6	-24	67.0	-22	65.5	-24	57.7	-33
AQ	6/250+8/330		283440	--	--	--	--	84.8	80.6	1.1	--	70.1	-18	73.1	-14	72.8	-15	64.3	-25
CWQ	6/250+8/330			--	--	--	--	85.8	81.3	0.7	--	45.9	-46	71.1	-17	66.7	-22	9 Da	-100
CWQ	6/250+8/330		Avg.	--	--	--	--	85.3	81.0	0.9	81.0	58.0	-32	72.1	-15	69.8	-18	--	-62
CWQ	6/250+8/330		283444	--	--	--	--	84.4	80.4	1.0	--	73.5	-12	71.5	-14	67.8	-19	70.6	-15
CWQ	6/250+8/330			--	--	--	--	81.9	79.6	0.7	--	71.9	-14	73.1	-12	71.0	-15	73.1	-12
CWQ	6/250+8/330		Avg.	--	--	--	--	83.2	80.0	0.8	80.0	72.7	-13	72.3	-13	69.4	-17	71.8	-14
CWQ	6/250+8/330		283447	--	--	--	--	83.4	78.5	0.7	--	64.8	-22	65.6	-21	67.4	-19	70.5	-15
CWQ	6/250+8/330			--	--	--	--	82.2	79.9	0.8	--	70.8	-14	70.6	-15	72.3	-13	68.2	-18
CWQ	6/250+8/330		Avg.	--	--	--	--	82.8	79.2	0.8	79.2	67.8	-18	68.1	-18	69.8	-16	69.2	-16
CWQ	6/250+8/330		Overall Avg.	88.3	82.7	0.7	0.753	85.5	82.0	0.9	--	67.1	-22	71.4	-16	69.0	-19	--	-45

(Continued)

Table XL (continued)

THE EFFECT OF PROLONGED AGING AND QUENCHING RATES ON TENSILE PROPERTIES AND STRESS CORROSION CRACKING OF ALLOY 34 (i)

Quench	Age (a) t	Age (a) T	S. No.	Longitudinal TS ksi	Longitudinal YS ksi	Longitudinal El, % In 4D	YS/Density x 10⁶ In.	Transverse TS ksi	Transverse YS ksi	Transverse El, % In 4D	Stress Value Used	Unstressed TS ksi	Unstressed % Change	Stressed 25% TS ksi	Stressed 25% % Change	Stressed 50% TS, ksi or Days to Failure	Stressed 50% % Change	Stressed 75% TS, ksi or Days to Failure	Stressed 75% % Change
CWQ	16	330	283440	82.6(f)	76.2(f)	0.7(f)	0.694(f)	86.2	80.3	1.1	--	69.7	-18	72.0	-16	68.4	-20	62 Da	-100
CWQ	16	330		83.0(f)	75.7(f)	0.7(f)	0.689(f)	84.3	80.5	0.6	--	71.4	-16	72.8	-15	70.5	-18	9 Da	-100
CWQ	16	330		82.8(f)	76.0(f)	0.7(f)	0.692(f)	85.2	80.4	0.8	85.2	70.6	-17	72.4	-15	69.4	-19	--	-100
CWQ	6225+8/350		283443	--	--	--	--	83.3	75.6	1.7	--	70.1	-14	69.1	-15	68.9	-14	72.5	-11
CWQ	6225+8/350			--	--	--	--	80.1	75.6	1.1	--	72.5	-12	72.8	-11	71.1	-13	70.1	-14
CWQ	6225+8/350		Avg.	--	--	--	--	81.7	75.6	1.4	81.7	71.3	-13	71.0	-13	70.0	-14	71.3	-13
CWQ	48	315	283444	79.1(f)	73.1(f)	0.7(f)	0.666(f)	83.4	76.8	2.0	--	67.2	-18	75.0	-9	68.5	-16	68.6	-16
CWQ	48	315		82.1(f)	73.0(f)	0.7(f)	0.665(f)	80.5	76.0	1.2	--	72.0	-12	72.6	-11	69.1	-16	67.8	-17
CWQ	48	315		--	--	--	--	--	--	--	--	72.4	-12	--	--	--	--	--	--
CWQ	48	315		--	--	--	--	--	--	--	--	72.5	-12	--	--	--	--	--	--
CWQ	48	315	Avg.	80.6(f)	73.0(f)	0.7(f)	0.665(f)	82.0	76.4	1.6	82.0	71.0	-13	73.8	-10	68.8	[illegible]	68.2	-17
CWQ	48	315	283440	--	--	--	--	79.7	74.8	0.9	--	66.2	-15	64.5	-20	64.7	-19	66.0	-18
CWQ	48	315		--	--	--	--	80.5	75.6	0.9	--	67.1	-16	65.2	-19	65.1	-19	63.3	-21
CWQ	48	315	Avg.	--	--	--	--	80.1	75.2	0.9	75.2	67.6	-16	64.5	-19	64.7	-19	64.5	-19
CWQ	48	315	283444	--	--	--	--	74.6	71.0	0.7	--	66.5	-17	64.9	-19	66.6	-17	65.8	-18
CWQ	48	315		--	--	--	--	80.6	71.1	2.2	--	64.6	-20	64.8	-20	65.4	-19	65.5	-19
CWQ	48	315	Avg.	--	--	--	--	77.6	71.0	1.4	71.0	65.6	-19	64.8	-20	66.0	-18	65.6	-19
CWQ	48	315	283448	--	--	--	--	77.5	72.7	0.9	--	62.8	-18	63.2	-18	64.6	-16	63.4	-17
CWQ	48	315		--	--	--	--	76.2	72.7	1.2	--	63.8	-17	62.5	-19	61.8	-20	64.6	-16
CWQ	48	315	Avg.	--	--	--	--	76.8	72.7	1.0	72.7	63.3	-18	62.5	-18	63.2	-18	64.0	-17
CWQ	48	315	283447	--	--	--	--	74.6	70.1	0.5	--	63.3	-17	66.3	-13	64.8	-15	59.1	-23
CWQ	48	315		--	--	--	--	78.7	71.1	0.6	--	64.1	-16	64.5	-16	67.4	-12	57.5	-25
CWQ	48	315	Avg.	--	--	--	--	76.6	70.6	0.6	70.6	63.7	-17	65.4	-15	66.1	-14	58.3	-24
CWQ	48	315	Overall Avg.	80.6	73.0	0.7	0.665	78.6	73.2	1.1	--	67.1	-16	66.4	-16	65.8	-17	64.2	-19
CWQ	32	330	283440	--	--	--	--	75.6	72.5	1.0	--	77.7	-1	65.0	-17	67.3	-14	61.8	-21
CWQ	32	330		--	--	--	--	81.2	73.8	1.6	--	--	--	70.3	-10	68.8	-13	[illegible]	-23
CWQ	32	330	Avg.	--	--	--	--	78.4	73.2	1.3	78.4	77.7	-1	67.6	-14	68.0	-13	61.0	-22
CWQ	8	350	283440	--	--	--	--	78.2	71.7	0.9	--	68.4	-13	63.9	-18	70.1	-11	25 Da	-100
CWQ	8	350		--	--	--	--	78.2	71.7	1.1	--	69.3	-12	69.0	-12	69.3	-11	63.6	-19
CWQ	8	350	Avg.	--	--	--	--	78.2	71.7	1.0	78.2	68.8	-12	66.4	-15	69.7	-11	--	-60
BWQ	24	250	283443	--	--	--	--	78.6	72.5	0.9	--	60.7	-21	60.7	-21	69.0	-10	3 Da	-100
BWQ	24	250		--	--	--	--	75.0	73.4	1.1	--	56.1	-24	68.6	-11	65.9	-14	3 Da	-100
BWQ	24	250		--	--	--	--	--	--	--	--	--	--	--	--	64.6	-16	--	--
BWQ	24	250	Avg.	--	--	--	--	76.8	73.0	1.0	76.8	59.4	-23	64.6	-16	66.5	-13	--	-100
BWQ	24	250	283440	--	--	--	--	75.7	69.6	1.0	--	58.3	-24	58.8	-23	59.0	-23	24 Da	-100
BWQ	24	250		--	--	--	--	77.1	69.3	0.9	--	63.5	-17	63.1	-17	65.0	-15	28 Da	-100
BWQ	24	250	Avg.	--	--	--	--	76.4	69.6	1.0	76.4	60.9	-20	61.0	-20	62.0	-19	--	-100
BWQ	24	250	283444	--	--	--	--	72.6	72.4	0.9	--	58.0	-21	62.8	-15	62.4	-15	53.7	-27
BWQ	24	250		--	--	--	--	74.8	72.2	0.9	--	64.5	-11	63.1	-16	57.9	-21	57.4	-22
BWQ	24	250	Avg.	--	--	--	--	73.7	72.3	0.9	73.7	61.7	-16	63.0	-15	60.2	-18	55.6	-25
BWQ	24	250	Overall Avg.	--	--	--	--	75.6	71.6	0.9	--	60.5	-20	62.8	-17	63.4	-16	--	-75
BWQ	8	330	283443	--	--	--	--	68.2	61.2	1.5	--	58.5	-14	59.1	-13	55.7	-18	57.[illegible]	-1[illegible]
BWQ	8	330		--	--	--	--	68.3	62.4	0.9	--	59.7	-12	60.3	-12	56.4	-18	55.9	-17
BWQ	8	330	Avg.	--	--	--	--	68.2	61.8	1.2	68.2	59.1	-13	59.7	-13	56.0	-18	55.8	-17

(a) All samples SHT 2 hrs at 860°F
(b) Failed before reaching 0.2% offset
(c) Avg. of 3 or more values
(d) Not obtained
(e) Does not include data from 28 day AI test
(f) S. No. 283445 data
(g) S. No. 277406 data
(h) Data for 28 day AI test
(i) Al 7.8 Zn, 2.5 Mg, 1.0 Cu, 3.5 Fe, 4.9 Ni 0.09 Cr.

Table XLI

THE EFFECT OF PROLONGED AGING ON TENSILE PROPERTIES AND STRESS CORROSION CRACKING OF ALLOY 79

S. No. 283188 (b)

Age (a)		Longitudinal				Transverse				Unstressed		Stressed 25% YS		Stressed 50% YS		Stressed 75% YS	
t	T	TS ksi	YS ksi	El, % In 4D	YS/Density x10^6 In.	TS ksi	YS ksi	El, % In 4D	Stressed Value, Used, ksi	TS ksi	% Change	TS ksi	% Change	TS,ksi or Days to Failure	% Change	TS,ksi or Days to Failure	% Change
24	250	9.72(d)	88.8(d)	5.5(d)	0.856(d)	90.2(d)	81.6(d)	4.1(d)	--	74.9	-12	61.1	-28	84 Da	-100	52 Da	-100
		96.3(e)	87.3(e)	2.7(e)	0.842(e)	84.1(e)	75.4(e)	3.4(e)	--	75.1	-12	59.9	-22	48.6	-43	52 Da	-100
	Avg.	96.9(c)	88.0(c)	3.7(c)	0.849(c)	86.7(c)	77.5(c)	3.8(c)	75.5	75.0	-12	63.5	-25	--	-72	--	-100
6	250+	86.4	77.0	7.5	0.743	79.3	71.1	3.5	--	71.3	-10	72.7	-8	70.9	-10	70.6	-11
8	330	--	--	--	--	78.7	70.1	3.4	--	71.3	-10	72.9	-8	70.6	-11	72.5	-8
	Avg.	86.4	77.0	7.5	0.743	79.0	70.6	3.4	70.6	71.3	-10	72.8	-8	70.5	-10	71.6	-9
16	330	80.2	68.5	9.0	0.661	74.4	64.5	4.5	--	68.0	-9	69.3	-8	68.0	-9	66.5	-11
		--	--	--	--	75.8	64.5	6.4	--	68.1	-9	69.4	-8	64.5	-14	63.9	-15
	Avg.	80.2	68.5	9.0	0.661	75.1	64.5	5.4	64.5	68.0	-9	69.4	-8	66.2	-12	65.2	-13
48	315	78.4	66.2	9.0	0.638	71.7	61.5	3.9	--	62.8	-14	63.6	-13	62.0	-15	65.9	-10
		--	--	--	--	74.6	61.7	7.2	--	63.2	-14	63.7	-13	63.7	-13	60.4	-17
	Avg.	78.4	66.2	9.0	0.638	73.2	61.6	5.6	61.6	63.0	-14	63.6	-13	62.8	-14	63.2	-14

Notes: (a) SHT 2 hrs. at 860°F, CWQ, Aged as noted.

(b) Al, 6.8 Zn, 2.8 Mg, 2.1 Cu, 1.0 Mn, 0.5 Cr, 0.1 Zr.

(c) Avg. of 3 or more test values.

(d) Highest test value.

(e) Lowest test value.

Table XLII

THE EFFECT OF PROLONGED AGING ON TENSILE PROPERTIES AND STRESS CORROSION CRACKING OF ALLOY 87

S. No. 283196 (b)

Age (a)		Longitudinal				Transverse				Unstressed		Stressed 25% Y.S.		Stressed 50% Y.S.		Stressed 75% Y.S.	
t	T	TS ksi	YS ksi	El, % In 4D	YS/Density x 10^6	TS ksi	YS ksi	El, % In 4D	Stress Value Used, ksi	TS. ksi	% Change	TS ksi	% Change	TS, ksi or Days to Failure	% Change	TS, ksi or Days to Failure	% Change
24	250	106.6(d)	99.3(d)	5.1(d)	0.938(d)	97.6(d)	92.2(d)	1.5(d)	--	60.6	-33	58.5	-35	82 Da	-100	1 Da	-100
		103.7(e)	98.8(e)	1.0(e)	0.934(e)	87.9(e)	86.9(e)	0.7(e)	--	58.5	-35	55.2	-39	58	-35	1 Da	-100
	Avg.	104.8(c)	99.1(c)	2.6(c)	0.937(c)	92.5(c)	89.5(c)	1.1(c)	87.2	59.6	-34	56.8	-37	--	-68	--	-100
6	250+	90.1	80.7	7.0	0.763	83.9	75.6	2.7	--	67.5	-20	70.0	-17	68.7	-18	59.8	-29
8	330	--	--	--	--	84.0	76.0	2.9	--	67.5	-20	70.8	-16	67.1	-20	50.6	-40
	Avg.	90.1	80.7	7.0	0.763	84.0	75.8	2.8	75.8	67.5	-20	70.4	-16	67.9	-19	55.2	-34
16	330	85.7	74.6	7.0	0.705	77.5	70.3	2.7	--	62.7	-20	66.6	-15	63.5	-19	66.2	-16
		--	--	--	--	79.9	70.1	3.9	--	65.2	-17	65.8	-16	67.6	-14	64.4	-18
	Avg.	85.7	74.6	7.0	0.705	78.7	70.2	3.3	70.2	64.0	-19	66.2	-16	65.6	-17	65.3	-17
48	315	82.9	69.5	10.0	0.657	77.6	65.9	3.8	--	60.5	-22	60.2	-23	62.4	-20	61.0	-22
		--	--	--	--	77.9	66.4	3.5	--	60.9	-22	61.1	-21	61.0	-22	61.8	-21
	Avg.	82.9	69.5	10.0	0.657	77.8	66.2	3.6	66.2	60.7	-22	60.6	-22	61.7	-21	61.4	-21

Notes: (a) SHT 2 hrs. at 860, CWQ, Aged as noted.

(b) Al, 7.6 Zn, 2.5 Mg, 1.1 Cu, 2.2 Fe, 2.3 Ni, 0.16 Cr.

(c) Avg. of 3 or more test values.

(d) Highest test value.

(e) Lowest test value.

Table XLIII

THE EFFECT OF PROLONGED AGING ON TENSILE PROPERTIES AND STRESS CORROSION CRACKING OF ALLOY 90

S. No. 294014

Age (c) T	T	Longitudinal TS ksi	Longitudinal YS ksi	Longitudinal El. % In 4D	Longitudinal YS/Density x10⁶ In.	Transverse TS ksi	Transverse YS ksi	Transverse El. % In 4D	Unstressed TS(a) ksi	Unstressed %(a) Change	Unstressed TS(b) ksi	Unstressed %(b) Change
24	250	90.8	92.4	5.4	0.885	87.6	80.5	2.4	76.2	-13	72.0	-17
		91.1	93.6	5.4	0.897	86.5	80.7	2.3	76.1	-13	74.6	-14
		--	--	--	--	--	--	--	--	--	--	--
	Avg.	91.0	93.0	5.4	0.891	87.0	80.6	2.4	76.2	-13	73.3	-16
6 +	250	84.4	77.9	8.6	0.746	79.5	71.3	5.8	71.1	-8	62.4	-22
8	330	84.4	78.1	7.9	0.748	75.2	70.9	2.9	70.3	-9	66.3	-17
		--	--	--	--	--	--	--	--	--	--	--
	Avg.	84.4	78.0	8.2	0.747	77.4	71.1	4.4	70.7	-9	64.4	-19
16	330	77.7	68.7	9.3	0.658	72.3	65.0	4.0	66.1	-9	63.7	-12
		78.2	70.0	10.0	0.670	73.2	65.4	5.3	67.0	-8	64.9	-11
		--	--	--	--	--	--	--	--	--	--	--
	Avg.	78.0	69.4	9.6	0.665	72.8	65.2	4.6	66.6	-9	64.3	-12
48	315	76.7	67.7	10.0	0.657	71.1	64.2	3.9	65.4	-5	67.2	-5
		76.9	68.2	7.9	0.648	66.3	64.2	1.2	65.1	-5	64.1	-10
		--	--	--	--	--	--	--	--	--	--	--
	Avg.	76.8	68.0	9.0	0.651	68.7	64.2	2.6	65.2	-5	65.6	-8

Age (c) T	T	Stress > 25% YS (b) % YS Level	Stress > 25% YS (b) TS ksi	Stress > 25% YS (b) % Change	Stressed 25% YS (a) TS ksi	Stressed 25% YS (a) % Change	Stressed 25>50% YS (b) % YS Level	Stressed 25>50% YS (b) TS ksi	Stressed 25>50% YS (b) % Change	Stressed 50% YS (b) TS, ksi or Days to Failure	Stressed 50% YS (b) % Change	Stressed 50><75% YS (b) % YS Level	Stressed 50><75% YS (b) TS, ksi or Days to Failure	Stressed 50><75% YS (b) % Change	Stressed 75% YS (a) TS, ksi or Days to Failure	Stressed 75% YS (a) % Change	Stressed > 75% YS (b) % YS Level	Stressed > 75% YS (b) TS, ksi or Days to Failure	Stressed > 75% YS (b) % Change
24	250	20	72.6	-17	73.7	-15	41	67.5	-22	5 Da	-100	61	9 Da	-100	3 Da	-100	--	--	--
		20	66.7	-23	73.9	-15	41	71.1	-18	5 Da	-100	61	18 Da	-100	2 Da	-100	--	--	--
		20	66.8	-23	68.9	-21	41	50.2	-42	16 Da	-100	61	21 Da	-100	3 Da	-100	--	--	--
	Avg.	20	68.7	-21	72.2	-17	41	62.9	-28	--	-100	61	--	-100	--	-100	--	--	--
6 +	250	23	66.7	-16	70.4	-9	46	68.6	-14	67.7	-13	69	73 Da	-100	63.0	-19	--	--	--
8	330	23	69.2	-13	68.9	-11	46	69.4	-13	69.1	-10	69	73 Da	-100	58.5	-25	--	--	--
		23	69.0	-13	69.8	-10	46	64.4	-19	69.8	-10	69	55.5	-30	65.3	-16	--	--	--
	Avg.	23	68.3	-14	69.7	-10	46	67.5	-15	68.9	-11	69	--	-77	62.3	-20	--	--	--
16	330	--	--	--	65.5	-10	27	64.3	-12	64.0	-12	55	58.1	-20	63.8	-12	82	63.1	-13
		--	--	--	65.1	-11	27	63.7	-12	66.3	-9	55	61.1	-16	63.0	-14	82	58.6	-19
		--	--	--	65.3	-10	27	64.1	-12	65.3	-10	55	62.8	-14	61.5	-16	82	61.6	-15
	Avg.	--	--	--	65.3	-10	27	64.0	-12	65.2	-10	55	60.7	-17	62.8	-14	82	61.1	-16
48	315	--	--	--	62.3	-9	30	63.2	-11	59.1	-14	61	65.3	-6	63.1	-8	92	61.5	-14
		--	--	--	65.0	-5	30	61.9	-13	63.7	-7	61	61.7	-13	--	--	92	61.6	-13
		--	--	--	63.5	-8	30	62.6	-12	--	--	61	63.1	-11	62.8	-9	92	60.5	-15
	Avg.	--	--	--	63.6	-8	30	62.6	-12	61.4	-11	61	63.4	-11	63.0	-8	92	61.2	-14

(a) Exposed to 3 1/2% NaCr AI test for 28 days
(b) Exposed to 3 1/2% NaCr AI test for 84 days
(c) All samples SHT 2 hrs. at 860°F, CWQ, Aged as noted
(d) Al, 7.5 Zn, 2.4 Mg, 1.0 Cu, 1.1 Fe, 1.0 Ni, 0.2 Cr

Table XLIV

STRESS CORROSION CRACKING RESISTANCE OF APM ALLOYS EXPOSED TO

3% NaCl: ALTERNATE IMMERSION TEST BATH

Alloy No.	S. No.	Age #2 (a, b) Time At 330°F. Hrs.	Longitudinal T.S. ksi	Longitudinal Y.S. ksi	Longitudinal EL, % in 4D	Transverse T.S. ksi	Transverse Y.S. ksi	Transverse EL, % in 4D	SCC (Stress-Failure Time) (f) 75% (j) Stress ksi	75% (j) Time Days	50% (j) Stress ksi	50% (j) Time Days	25% (j) Stress ksi	25% (j) Time Days
34	283442	-D-	110	109	0	102	(g)	<1	---	---	51	1,1	26	OK28(2)
52	283493	-D-	116	112	0	102	98	<1	---	---	51	1,2	26	9,OK28
34	283442	0	106(c)	103(c)	<1(c)	101	(g)	(h)	---	---	50	1,1,1	25	OK28(3)
34	283444	0	106(c)	103(c)	<1(c)	100	(g)	(h)	75	1,1	50	1,2	25	OK84(2)
34	283441	0	106(c)	103(c)	<1(c)	100	(g)	(h)	75	1,1	50	2,2	25	OK84(2)
52	283492	0	106(c)	103(c)	2(c)	98	(g)	(h)	---	---	49	1,1,1	24	OK84(3)
38	283452	-D-	116	111	<1	98	(g)	0	---	---	49	1,1	24	5,5
36	283451	0	112	108	1	97	97	(h)	74	1,1	48	1,2	24	6,17
50	283483	-D-	115	113	0	97	(g)	(h)	---	---	48	2,2	24	1,5
34	283443	0	106(c)	103(c)	<1(c)	97	(g)	(h)	74	1,2,2	48	1,3	24	OK84(2)
87	293196	0	105	99	3	92	90	1	68	1,1	45	82,OK84	22	OK84(2)
52	293490	0	109	106	3	90	90	(h)	68	5,6	45	12,15	22	OK84(2)
34	283444	-A-	88(c)	83(c)	<1(c)	90	88	1	68	31,61	45	OK84(2)	22	OK84(2)
34	283443	-F-	(d)	(d)	(d)	89	(g)	(h)	67	3,3	44	OK84(2)	22	OK84(2)
71	293387	0	108	105	5	92	88	1	66	7,13	44	18,22	22	OK84(2)
28	277400	1	101(e)	97(e)	3(e)	86	81	1	64	<1,<1	43	<1,<1	22	OK84(2)
34	283440	-B-	83(c)	76(c)	<1(c)	85	60	1	64	9,62	42	OK84(2)	21	OK84(2)
34	283440	0	106(c)	104(c)	<1(c)	84	(g)	(h)	63	1,2	42	2,2	21	OK84(2)
34	283448	-A-	88(c)	83(c)	<1(c)	86	82	1	62	OK84(2)	41	OK84(2)	20	OK84(2)
61	283759	8	88(e)	83(e)	7(e)	82	76	1	62	6,7	41	21,35	20	OK84(2)
34	283443	-C-	(d)	(d)	(d)	82	76	1	62	OK84(2)	41	OK84(2)	20	OK84(2)
34	283444	-C-	81(c)	73(c)	<1(c)	82	76	2	62	OK84(2)	41	OK84(2)	20	OK84(2)
90	294014	0	99	93	5	87	81	2	61	2,3,3	40	5,5,16	20	OK28(3)
34	283440	-A-	(d)	(d)	(d)	85	81	1	61	9,OK84	40	OK84(2)	20	OK84(2)
52	283490	4	94	89	4	84	80	1	60	25,33	40	OK84(2)	20	OK84(2)
34	283444	-A-	88(c)	83(c)	<1(c)	83	80	1	60	OK84(2)	40	OK84(2)	20	OK84(2)
3	277375	3	102(e)	99(e)	3(e)	80	(g)	<1	60	2,3	40	24,27	20	OK84(2)
3	277375	7	89(e)	85(e)	4(e)	80	78	<1	60	9,9	40	29,53	20	OK84(2)
28	277400	8	87(e)	83(e)	5(e)	80	77	1	60	11,11	40	37	20	OK84(2)
19	277391	8	88(e)	83(e)	10(e)	80	74	4	60	24,32	40	44,60	20	OK84(2)
90	294014	-C-	77	68	9	69	64	3	60(k)	OK84(3)	40(k)	OK84(3)	20(k)	OK84(3)
71	293387	3	94	88	7	84	79	3	59	31,31	40	OK84(2)	20	OK84(2)
34	283447	-A-	88(c)	83(c)	<1(c)	83	79	1	59	OK84(2)	40	OK84(2)	20	OK84(2)
20	277392	8	91(e)	85(e)	8(e)	79	76	1	59	7,9	40	24,35	20	OK84(2)
6	277378	5	90(e)	85(e)	8(e)	79	76	2	59	5,6	40	18,30	20	OK84(2)

(Continued)

Table XLIV Continued

STRESS CORROSION CRACKING RESISTANCE OF ARM ALLOYS EXPOSED TO

3% NaCl ALTERNATE IMMERSION TEST BATH

Alloy No.	S. No.	Age #2 (a, b) Time At 330°F. Hrs.	Longitudinal T.S. ksi	Longitudinal Y.S. ksi	Longitudinal El, % in 4D	Transverse T.S. ksi	Transverse Y.S. ksi	Transverse El, % in 4D	SCC (Stress-Failure Time) (f) 75% (1) Stress ksi	75% (1) Time Days	50% (1) Stress ksi	50% (1) Time Days	25% (1) Stress ksi	25% (1) Time Days
[illegible]	277392?	13	97(e)	81(e	5(e	[illegible]	[illegible]	[illegible]	59	11,26	40	45,47	20	OK84(2)
7?	293188	C	9?	88	4	64	76	4	58	52,52	39	84,OK84	20	OK84(2)
34?	28[illegible]	-H-	(d	(d	(d	[illegible]	[illegible]	[illegible]	5?	OK84(2	35	OK84(2)	20	OK84(2)
34?	28[illegible]	-E-	(d	d	(d	[illegible]	72	[illegible]	5?	24,OK84	39	OK84(2)	20	OK84(2)
34?	28[illegible]	-I-	(d	(d	(d	[illegible]	[illegible]	[illegible]	58	3,?	36	OK84(2)	19	OK84(2)
[illegible]	277374?	6	88(e	85(e	5(e	[illegible]	8?	<1	58	[illegible]	38	40,68	19	OK84(2)
[illegible]	277392	12	85(e	79(e	10(e	[illegible]	7?	[illegible]	55	32,3?	38	54,57	19	OK84(2)
87?	293194?	-A-	90	81	7?	54?	7?	[illegible]	57	OK84(2	36	OK84(2)	19	OK84(2)
4?	277376?	8	88	82(	5(e	[illegible]	[illegible]	<1	5?	2?	38	15,16	19	OK84(2)
[illegible]	28[illegible]	-I-	(d	(d	(d	[illegible]	65	[illegible]	5?	22,25	38	OK84(2)	19	OK84(2)
[illegible]	277392	19	82(e	73(e	11(e	[illegible]	68?	[illegible]	5?	44,50	36	OK84(2)	19	OK84(2)
34?	28[illegible]	-C-	81(c	73(c	<1(c	66?	[illegible]	[illegible]	56	OK84(2)	38	OK84(2)	19	OK84(2)
[illegible]	277374	6	85(e	81(e	6(e	[illegible]	[illegible]	[illegible]	[illegible]	13,25	38	OK84(2)	19	OK84(2)
[illegible]	2773??	40	83	68	2	[illegible]	68	<1	[illegible]	6,OK84	38	OK84(2)	19	OK84(2)
2?	277392	25	81(e	72(e	9(e	[illegible]	6?	[illegible]	56	33,35	38	17,OK84	19	OK84(2)
36?	277935?	10	85(e	79(e	3(e	74?	78?	<1	56	1,3	37	24,54	18	OK84(2)
34	28[illegible]	-I-	(d	(d	(d	74	72?	[illegible]	56	OK84(2)	37	OK84(2)	18	OK84(2)
[illegible]	277392	25	78(e	70(e	11(e	74	64?	5	56	47,57	37	OK84(2)	18	OK84(2)
4?	28[illegible]	-C-	81(c	73(c	<1(c	[illegible]	[illegible]	1	55	OK84(2)	36	OK84(2)	18	OK84(2)
[illegible]	283759?	22	80(e	72(e	9(e	[illegible]	65	2	55	24,35	36	OK84(2)	18	OK84(2)
[illegible]	277392	40	77	65	10	7?	64	4	55	44,48	36	OK84(2)	18	OK84(2)
[illegible]	29[illegible]	5	8?	60	9	77	72	[illegible]	54	45,54	36	OK84(2)	18	OK84(2)
[illegible]	277376	6	89(e	85(e	4(e	72	(g	<1	54	1,2	36	33,37	18	OK84(2)
[illegible]	277375	17	79(e	72(e	6(e	72	68	<1	54	32,32	36	OK84(2)	18	OK84(2)
28	277400	22	79(e	71(e	6(e	72		[illegible]	54	29,32	36	OK84(2)	18	OK84(2)
90?	294014	-B-	78	69	10	7?	65	5	54(1)	OK84(3)	36(1)	OK84(3)	18(1)	OK84(3)
79	293188	-A-	86	77	8	79	71	3	54	OK84(2)	36	OK84(2)	17	OK84(2)
34	28[illegible]	-C-	81(c	73(c	<1(c	78	71	1	54	OK84(2)	36	OK84(2)	17	OK84(2)
34	28[illegible]	-C-	81(c	73(c	<1(c	77	71	1	54	O[illegible]2)	36	OK84(2)	17	OK8[illegible](2)
90?	2940??	-A-	84	78	8	77	71	4	54	[illegible]4(3)	36	OK28(3)	17	OK28(3)
[illegible]	283462?	-D-	107	105	0?	71	(g	(h)	---	---	36	1,1	17	9
6?	283759	30	77(e	69(e	10(e	71	65	2	54	24,35	36	OK84(2)	17	OK84(2)
87?	293194	-B-	86	75	7	79	70	3	53	OK84(2)	35	OK84(2)	17	OK84(2)
[illegible]	277405	1?	87(e	79(e	7(e	70	(g	<1	53	11,11	35	75,OK84	17	OK84(2)
[illegible]	277374	18	78(e	71(e	8(e	70	68	1	53	11,57	35	OK84(2)	17	OK84(2)
[illegible]	27737?	17	80(e	72(e	10(e	70	67	2	53	[illegible]	35	47,60	17	OK84(2)
[illegible]	[illegible]	23	75(e	6?(e	6(e	70	66	2	53	35,44	35	OK84(2)	17	OK84(2)
[illegible]	2773??	19	79(e	70(e	7(e	69	67	<1	52	7,9	35	15,41	17	OK84(2)
[illegible]	283755?	40	75	71	5	69?	65	<1	52	5,6	35	OK84(2)	17	OK84(2)
[illegible]	277[illegible]	26	80(e	70(e	3(e	69	66	1	52	7,7	35	OK84(2)	17	OK84(2)
33?	277405	26	81(e	71(e	7(e	69	66	2	52	21,24	35	OK84(2)	17	OK84(2)
[illegible]	277375	24	77(e	69(e	12(e	69	64	2	52	11,20	35	40,OK84	17	OK84(2)
28	277400	32	76(e	67(e	7(e	68	64	2	51	26,49	34	OK84(2)	17	OK84(2)
34	28[illegible]	-J-	(d	(d	(d	68	62	1	51	OK84(2)	34	OK84(2)	17	OK84(2)
[illegible]	27737?	*	84(e)	72(e)	5(e)	67	(g)	<1	50	3,9	34	OK84(2)	17	OK84(2)

(Continued)

Table XLIV (Continued)

STRESS CORROSION CRACKING RESISTANCE OF APM ALLOYS EXPOSED TO

3½ NaCl: ALTERNATE IMMERSION TEST BATH

		Age #2 (a, b)	Longitudinal			Transverse			SCC (Stress-Failure Time) (f)					
									75% (j)		50% (j)		25% (j)	
Alloy No.	S. No.	Time At 330°F, Hrs.	T.S. ksi	Y.S. ksi	EL, % In 4D	T.S. ksi	Y.S. ksi	EL, % In 4D	Stress ksi	Time Days	Stress ksi	Time Days	Stress ksi	Time Days
36	277938	36	79(e)	67(e)	3(e)	67	64	1	50	21,69	34	OK84(2)	17	OK84(2)
4	277376	27	76(e)	65(e)	7(e)	67	63	<1	50	9,11	34	49,69	17	OK84(2)
87	293196	-C-	83	70	10	78	66	4	50	OK84	33	OK84(2)	16	OK84(2)
2	277374	28	74(e)	66(e)	9(e)	66	63	1	50	61,OK84	33	OK84(2)	16	OK84(2)
90	296014	-A-	84	75	8	77	71	4	49(m)	73,73, OK84	33(m)	OK84(3)	16(m)	OK84(3)
38	283453	18	82	70	4	76	65	3	49	26,84	32	OK84(2)	16	OK84(2)
90	296014	-F-	78	69	10	[illegible]	65	5	.9	OK28(3)	32	OK28(3)	16	OK28(3)
5	277377	25	81(e)	67(e)	5(e)	[illegible]	64	<1	49	11,44	32	OK84(2)	16	OK84(2)
36	277939	36	78(e)	65(e)	4(e)	65	6[illegible]	<1	49	14,34	32	OK84(2)	16	OK84(2)
90	296014	-D-	99	93	5	87	81	2	48(n)	9,18,21	32(n)	OK84(3)	16(n)	OK84(3)
71	293187	20	81	71	8	75	64	6	48	OK84(2)	32	OK84(2)	16	OK84(2)
79	293188	-B-	80	68	9	75	64	5	48	(2)	32	OK84(2)	16	OK84(2)
90	296014	-C-	77	68	9	69	64	3	48	[illegible](2)	32	OK28(2)	16	OK28(2)
33	277405	35	79(e)	67(e)	7(e)	64	62	<1	48	35,41	32	OK84(2)	16	OK84(2)
52	283495	24	79	70	6	72	63	3	47	OK84(2)	32	OK84(2)	16	OK84(2)
79	293188	-C-	78	66	9	73	62	6	46	OK84(2)	31	OK84(2)	16	OK84(2)
49	283472	-	110	108	<1	[illegible]	(g)	(h)	--	-----	26	2,3	13	4,8
7178-T651 (i)			92	84	8	83	74	5-6	56	1 to 12	37	1 to 13	18	2 to OK84
7075-T651 (i)			88	80	11	75	65	4-5	49	1 to 12	32	1 to 13	16	2 to OK84
7075-T7351 (i)			75	66	11	67	56	3-4	42	OK84	28	OK84	14	OK84

(a) All specimens SHT 2 Hrs at 860°F, CWQ, Aged #1, 24 Hrs at 250°F, Age #2, as noted (exceptions are listed (b)).

(b) Heat Treatment Used

- -A- Age #1 4 Hrs at 250°F, + Age #2 6 Hrs at 330°F.
- -B- Age #1, 16 Hrs at 330°F.
- -C- Age #2, 48 Hrs at 315°F.
- -D- SHT ½ Hr at 920°F, CWQ, Age #1 96 Hrs at 225°F.
- -E- Age #1, 8 Hrs at 350°F.
- -F- Age #1, 8 Hrs at 330°F.
- -G- Age #1, 6 Hrs at 225°F, Age #2, 6 Hrs at 350°F.
- -H- Age #1, 32 Hrs at 330°F.
- -I- BWQ, Aged #1, 24 Hrs at 250°F.
- -J- BWQ, Aged #1, 8 Hrs at 340°F.
- -O- No Age #2

(c) Tensile properties were determined on another extrusion.
(d) Not determined.
(e) Predicted values from available data.
(f) Each value represents one specimen except for run outs where number of specimens are given in parenthesis.
(g) Failed before reaching 0.2% offset.
(h) Specimen shattered
(i) Typicals from [illegible] sent 3/23/65 2 to 3 in. [illegible] extrusions.
(j) Stress levels except when noted.
(k) Stress levels used, 72%, 61%, and 30%, respectively.
(l) Stress levels used, 52%, 55%, and 27%, respectively.
(m) Stress levels used, 49%, 46%, and 23%, respectively.
(n) Stress levels used, 41%, 41%, and 20%, respectively.

Table XLV

A. P. M. ALLOYS MEETING STRESS CORROSION AND STRENGTH TARGETS

Alloy	Composition, % Zn	Mg	Cu	Other	Aging (a)	Longitudinal T.S. ksi	Y.S. ksi	El., % in 4D	SCC (b) Stress ksi	Days to Failure
Target I: 7075-T7351 + 10% with no failures at 75% Y.S.						83	73	5	>48	O K 84
A. Meets Target										
87	7.6	2.5	1.1	2.2 Fe, 2.3 Ni, .2 Cr.	6 @ 250 + 8 @ 330	90	81	7	57	O K 84
87	7.6	2.5	1.1	2.2 Fe, 2.3 Ni, .2 Cr.	16 @ 330	86	75	7	52	O K 84
73	6.8	2.8	2.1	1.0 Mn, .5 Cr, .1 Zr.	6 @ 250 + 8 @ 330	86	79	8	54	O K 84
90	7.5	2.4	1.0	1.1 Fe, 1.0 Ni, .2 Cr.	6 @ 250 + 8 @ 330	84	78	8	54	O K 84
B. May Meet Target After Changes in Aging Practices										
71	9.3	3.6	.5	.7 Co, .02 Cr, .02 Ti.	24 @ 250 + 8 @330	87	80	9	60	45,54
52	10.0	4.0	.9	1.5 Co, .01 Cr, .02 Ti	24 @ 250 + 4 @330	94	89	4	54	33,33
34	7.8	2.5	1.0	3.5 Fe, 4.9 Ni, .09 Cr	6 @ 250 + 8 @ 330	88	83	<1	61	O K 84
Target II: 7178-T651 + 10% Strength Improvement, Equal Stress Corrosion Resistance						101	92	5	7-20	O K 84
A. Meets Target										
71	9.3	3.6	.5	.7 Co, .02 Cr, .02 Ti	24 @ 250	108	105	5	22	O K 84
B. May Meet Target After Changes in Aging Practices										
52	10.0	4.0	.9	1.5 Co, .01 Cr, .02 Ti	24 @ 250	106	103	2	45	12,15
87	7.6	2.5	1.1	2.2 Fe, 2.3 Ni, .2 Cr.	24 @ 250	105	99	3	45	82, OK84
52	10.0	4.0	.9	1.5 Co, .01 Cr, .02 Ti	24 @ 250	109	106	3	49	1,1
Target III: Better Stress Corrosion Resistance Than 7178-T651						92	84	5	7-20	O K 84
A. Meets Target										
71	9.3	3.6	.5	.7 Co, .02 Cr, .02 Ti	24 @ 250	108	105	5	22	O K 84
90	7.5	2.4	1.0	1.1 Fe, 1.0 Ni, .2 Cr	24 @ 250	99	93	5	20	O K 28
71	9.3	3.6	.5	.7 Co, .02 Cr, .02 Ti	24 @ 250 + 3 @330	94	88	7	40	O K 84
B. May Meet Target After Changes in Aging Practices										
52	10.0	4.0	.9	1.5 Co .01 Cr, .02 Ti	24 @ 250	106	103	2	24	O K 84
87	7.6	2.5	1.1	.02 Mn, 2.2 Fe, 2.3 Ni, .2 Cr.	24 @ 250	105	99	3	22	O K 84
52	10.0	4.0	.9	1.5 Co, .01 Cr, .02 Ti	24 @ 250 + 4 @ 330	94	89	4	40	O K 84
3	12.3	4.0	1.6	.5 Mn	24 @ 250 + 3 @330	102	99	3	20	O K 84
79	6.5	2.7	2.1	1.0 Mn, .5 Cr.	24 @ 250	97	88	4	20	O K 84

(a) All Specimens SHT 2 Hrs at 860°F, Cold water quenched, aged as noted.

(b) Exposed in 3½% NaCl AI bath at room temperature. Stressed in short transverse direction.

TABLE XLVI

ELECTRON MICROPROBE SEMI-QUANTITATIVE ANALYSIS OF LARGE CONSTITUENT PARTICLES

Alloy No.	S. No.(e)	Alloying Elements(a)	Constituent Composition, % Zn	Mg	Cu	Mn	Fe	Ni	Cr	Ti	V	Zr	Co	Mo	W	Al
14	277386	A	10	5	2	2	6	10	3(d)	—	—	—	—	—	—	57
15	277387	B	2	3	0	—	—	—	1	18	7	8	—	0	0	55
16	277388	C	1	0	0	—	—	—	7	12	17	2	—	—	—	59
17(b)	277389	D	16	9	4	—	—	—	—	—	—	—	0	12	12	47
17(c)	277389	D	3	3	0	—	—	—	—	—	—	—	0	16	32	51
18	277390	E	1	0	0	0	0	0	1	15	6	3	0	10	8	56

Note: Accuracy ± 10% of indicated value for amounts above 10%, ± 20% of indicated value for amounts below 10%.

(a) Base composition, Al-12% Zn-3.5% Mg-1.5% Cu to which were added

A - 1.5% each Mn, Fe, Ni
B - 0.5% each Cr, Ti, V, Zr
C - 2.0% Cr-0.8% Ti-2.0% V-1.0% Zr
D - 1.5% each Co, Mo, W
E - 0.3% each Mn, Fe, Ni, Cr, Ti, V, Zr, Co, Mo, W

(b) Light colored particle.

(c) Dark colored particles.

(d) Not an alloying element. Presence unexplained.

(e) Extrusions SHT 2 hrs at 860°F, CWQ, Aged 24 hrs at 250°F.

TABLE XLVII

PHASES PRESENT IN Al-Zn-Mg-Cu-Mn ALLOYS IN -T6 TEMPER

Alloy No.	S. No.	Composition, % Zn	Mg	Cu	Mn	Fe	Si	Phase (a) α (Al-Mn)	Al-Mg-Mn	α (Al-Cu-Fe) Type	M	T	Mg_2Si
1	277373	9.94	3.53	1.07	.52	.08	.05	M.	Tr?	W.	W.	M.W.	V.W.
33	277405	8.95	3.47	1.18	1.13	.15	.10	M.S.	Tr.	M.W.	M.	M.	V.W.
35	277407	9.01	3.41	1.16	2.53	.19	.11	S.	Tr.	M.S.	M.S.	M.S.	V.W.
36	277424	10.7	3.82	2.04	1.66	.13	.10	M.W.	V.W.	M.W.	V.W.	S.	V.W.

(a) Phases

α (Al-Mn)	= $MnAl_6$
Al-Mg-Mn	= $Al_{10}Mg_2Mn$
α (Al-Cu-Fe) type	= May contain some Mn
M	= $MgZn_2$
T	= $Al_2Mg_3Zn_3$

Diffraction line intensity relative to that from other alloys.

S.	= Strong
M.S.	= Medium strong
M.	= Medium
M.W.	= Medium weak
W.	= Weak
V.W.	= Very weak
Tr.	= Trace

Table XLVIII

ELECTRON MICROPROBE SEMI-QUANTITATIVE ANALYSIS

OF LARGE CONSTITUENT PARTICLES IN ALLOYS 34 AND 87

Alloy No.[(a)]	Particle No.	Particle Type	Constituent Composition, % Al	Mg	Zn	Fe	Ni	Cr	Cu	Mn	Zr	Si	Remarks
34	1,4,7,8, 10-14	Nonmetallic	-	-	-	-	-	-	-	-	40	10	Probably $Zr\ SiO_4$
	3	Nonmetallic	30	5	-	-	-	-	-	-	-	-	Spinel (?)
	9	Nonmetallic	-	30	-	-	-	-	-	-	10	5	
	2	Metallic	38	19	16	10	9	7	1	<1	-	-	
	5	Metallic	60	6	4	26	2	-	2	-	-	-	
	6	Metallic	35	34	4	24	2	-	1	-	-	-	
	15	Metallic	55	15	-	-	-	-	-	-	30	-	
87	1,3,9,11	Nonmetallic	-	-	-	-	-	-	-	-	40	10	Probably $Zr\ SiO_4$
	6	Nonmetallic	-	-	1	70	<1	-	-	-	-	-	
	7	Nonmetallic	4	25	3	-	-	-	1	-	-	-	
	8	Nonmetallic	13	6	1	-	-	-	-	-	-	40	
	12	Nonmetallic	10	25	3	-	-	-	-	-	-	-	
	2	Metallic	33	35	5	10	5	12	-	-	-	-	
	4	Metallic	36	30	4	26	4	-	-	-	-	-	
	5	Metallic	60	-	2	33	4	-	1	-	-	-	
	10	Metallic	1	-	35	27	12	25	-	-	-	-	
	13	Metallic	40	20	5	15	9	10	1	-	-	-	
	14	Metallic	40	21	6	16	5	10	2	-	-	-	

(a) Alloy 34, Al 7.77 Zn, 2.48 Mg, 1.03 Cu, 0.02 Mn, 3.49 Fe, 4.94 Ni, 0.09 Cr, 0.01 Ti, 0.07 Si, 0.59 Al_2O_3

Alloy 87, Al 7.58 Zn, 2.52 Mg, 1.06 Cu, 0.02 Mn, 2.16 Fe, 2.26 Ni, 0.16 Cr, 0.01 Ti, 0.01 V, 0.01 Co, 0.05 Si, 0.63 Al_2O_3

Table XLIX

ELECTRON MICROPROBE SEMI-QUANTITATIVE ANALYSIS

OF LARGE CONSTITUENT PARTICLES IN ALLOYS 52 AND 71

Alloy (a)	Particles	Partical Type	Al	Mg	Zn	Fe	Ni	Cr	Cu	Mn	Zr	Si	Co	Ca (b)	K (b)	Remarks
			Constituent Composition %													
52	2,5,7,9-15	Nonmetallic	-	-	-	-	-	-	-	-	40	10	-	-	-	Probably Zr SiO_4
	1	Nonmetallic	-	10	-	7	-	-	-	-	-	-	-	-	-	
	3	Nonmetallic	20	-	-	1	-	-	-	-	-	10	-	-	L	
	4	Nonmetallic	10	-	-	3	-	-	-	-	-	10	-	L	L	
	8	Nonmetallic	25	-	-	2	-	-	-	-	-	-	-	M	-	
	16B (c)	Nonmetallic	-	-	-	72	-	-	-	2	-	-	-	-	-	Fe_3O_4
	16A (c)	Metallic	56	-	2	42	-	-	-	-	-	-	-	-	-	$FeAl_3$
	16C (c)	Metallic	-	-	-	>95	-	-	-	2	-	-	-	-	-	Fe
71	3,C,E,H	Nonmetallic	-	-	-	-	-	-	-	-	40	10	-	-	-	Zr SiO_4
	2	Nonmetallic	10	5	-	-	-	-	-	-	-	-	-	-	-	
	5	Nonmetallic	7	5	-	<4	-	-	-	-	-	15	-	-	L	
	A	Nonmetallic	12	20	2	1	-	-	-	-	-	3	-	-	-	
	B	Nonmetallic	-	1	1	-	-	-	-	-	-	30	-	-	-	
	D	Nonmetallic	15	-	1	<1	-	-	-	-	-	10	-	-	M	
	G	Nonmetallic	15	15	2	<1	-	-	<1	-	-	3	-	-	-	
	I	Nonmetallic	15	15	2	<1	-	-	-	-	-	4	-	-	-	
	J	Nonmetallic	30	2	1	<1	-	-	-	-	-	4	-	-	-	
	1	Metallic	55	-	10	20	2	13	-	<1	-	-	-	-	-	
	4	Metallic	59	4	5	30	-	-	2	-	-	-	-	-	-	
	F	Metallic	55	10	7	25	-	-	3	-	-	-	<1	-	-	

(a) Alloy 52, Al, 9.99 Zn, 4.01 Mg, 0.92 Cu, 0.01 Mn, 0.14 Fe, 0.01 Ni, 0.01 Cr, 0.02 Ti, 1.49 Co, 0.06 Si, 0.75 Al_2O_3
Alloy 71 Al, 9.2 Zn, 3.62 Mg, 0.63 Cu, 0.02 Cr, 0.03 Ti, 0.75 Co, 0.26 Al_2O_3

(b) Since per cent standards are not readily available for these elements, L for Low and M for Moderate were used.

(c) Particle 16 is very large and is composed of three phases--a dark nonmetallic phase (16B--Fe_3O_4) one side, a light metallic phase (16A--$FeAl_6$) on the other side and a small amount of a second metallic phase (16C--Metallic Fe) in the center.

Table L

IDENTIFICATION OF PHASES IN POWDERS AND EXTRUDED SECTIONS

Alloy	S. No. (a)	Product	Age (b) t/T Hrs/°F	Phases: Al	Mg_2Si	$FeNiAl_9$	$MgZn_2$	$Al_{12}Mg_2Cr$	Co_2Al_9	$Mg_3Zn_3Al_2$	(e)	M'ppt
34	283269	Powder	----	✓	✓	(c) ✓	---	---	---	---	---	---
	283441	2"Ø Extrusion	24/250	✓	✓	(c) ✓	✓	✓	---	---	✓	---
	283441	2"Ø Extrusion	48/315	✓	✓	(c)(d)✓	✓	✓	---	---	✓	✓
87	307598	Powder	----	✓	✓	(c) ✓	---	---	---	---	---	---
	293196	2" Ø Extrusion	24/250	✓	✓	(c) ✓	✓	✓	---	---	✓	---
	293196	2" Ø Extrusion	48/315	✓	✓	(c)(d)✓	✓	✓	---	---	✓	✓
52	283274	Powder	----	✓	✓	---	---	---	✓	---	---	---
	283490	2" Ø Extrusion	24/250	✓	✓	---	✓	---	✓	✓	---	---
	283490	2" Ø Extrusion	24/250 + 20/330	✓	✓	---	✓	---	✓	✓	---	✓✓
71	283303	Powder	----	✓	✓	---	---	---	✓	---	---	---
	293387	2" Ø Extrusion	24/250	✓	✓	---	✓	---	✓	✓	---	---
	293387	2" Ø Extrusion	24/250 + 20/330	✓	✓	---	✓	---	✓	✓	---	✓

(a) Alloy	Zn	Mg	Cu	Mn	Fe	Ni	Cr	Ti	Co	V	Si
34	7.77	2.48	1.03	0.02	3.49	4.94	0.09	0.01	--	--	0.07
87	7.58	2.52	1.06	0.02	2.16	2.26	0.16	0.01	0.01	0.01	0.05
52	9.99	4.01	0.92	0.01	0.14	0.01	0.01	0.02	1.49	--	0.06
71	9.29	3.58	0.54	--	--	--	0.02	0.02	0.68	--	--

(b) Powders were as atomized, extrusions were SHT 2 Hrs at 860°F, CWQ, aged as noted.

(c) $FeNiAl_9$ finer in powder, amount increased in extrusion.

(d) The amount of $FeNiAl_9$ increases in extrusion.

(e) Four lines unidentified.

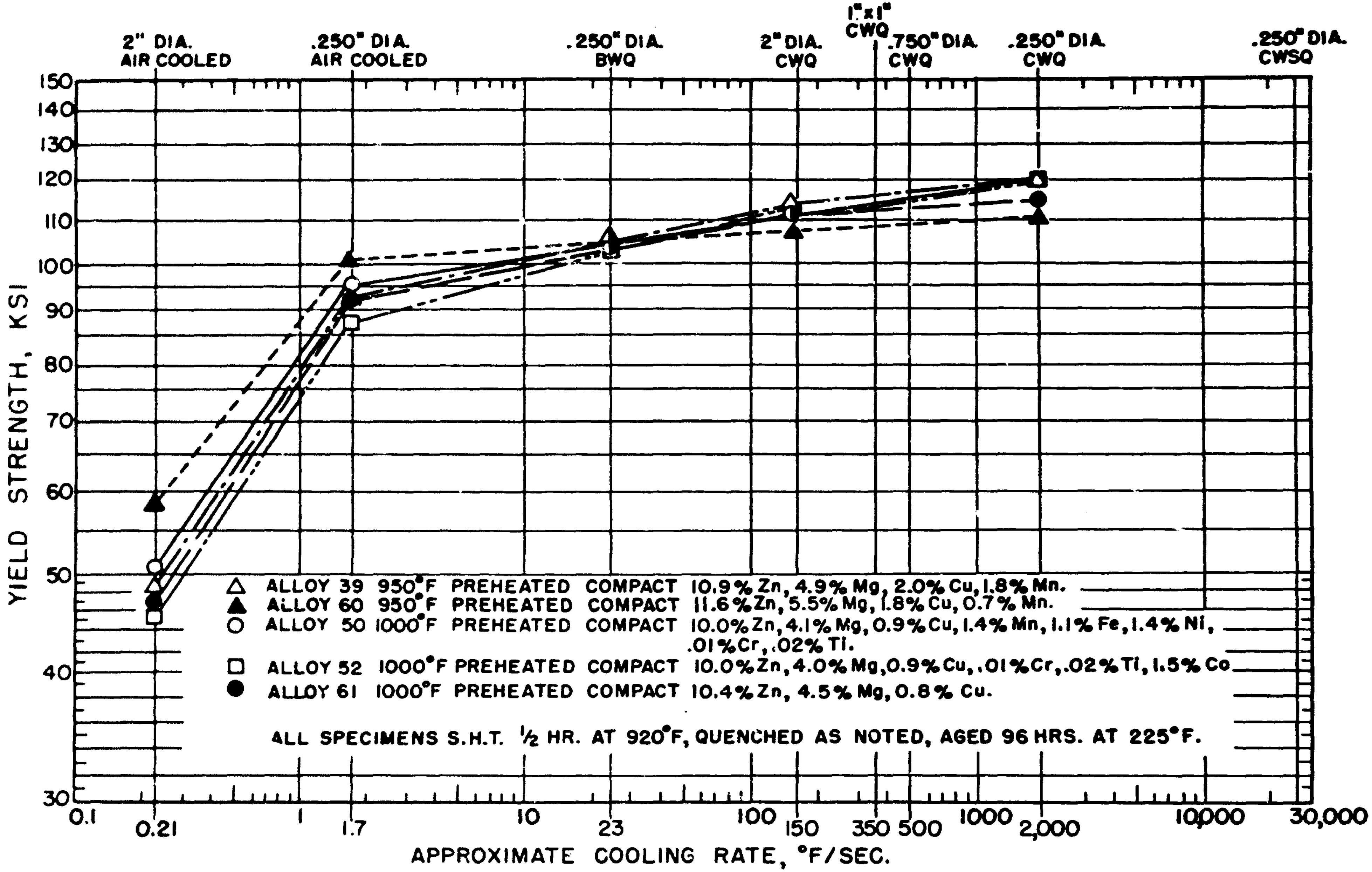


FIGURE 1

THE EFFECT OF COOLING RATE ON YIELD STRENGTHS OF EXTRUSIONS

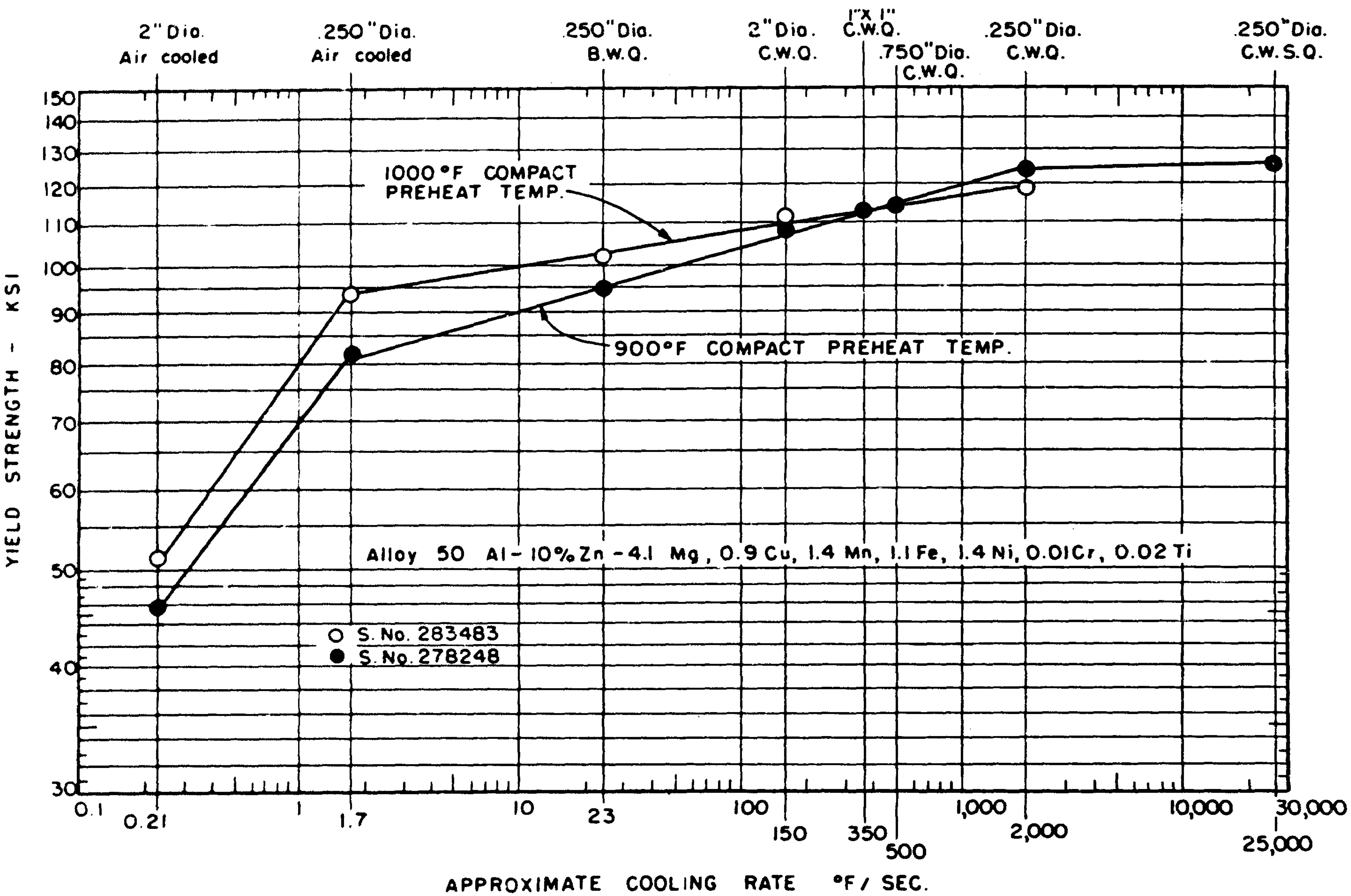


FIGURE 2

THE EFFECT OF COMPACT PREHEAT TEMPERATURE AND COOLING RATE ON ROOM TEMPERATURE LONGITUDINAL YIELD STRENGTH

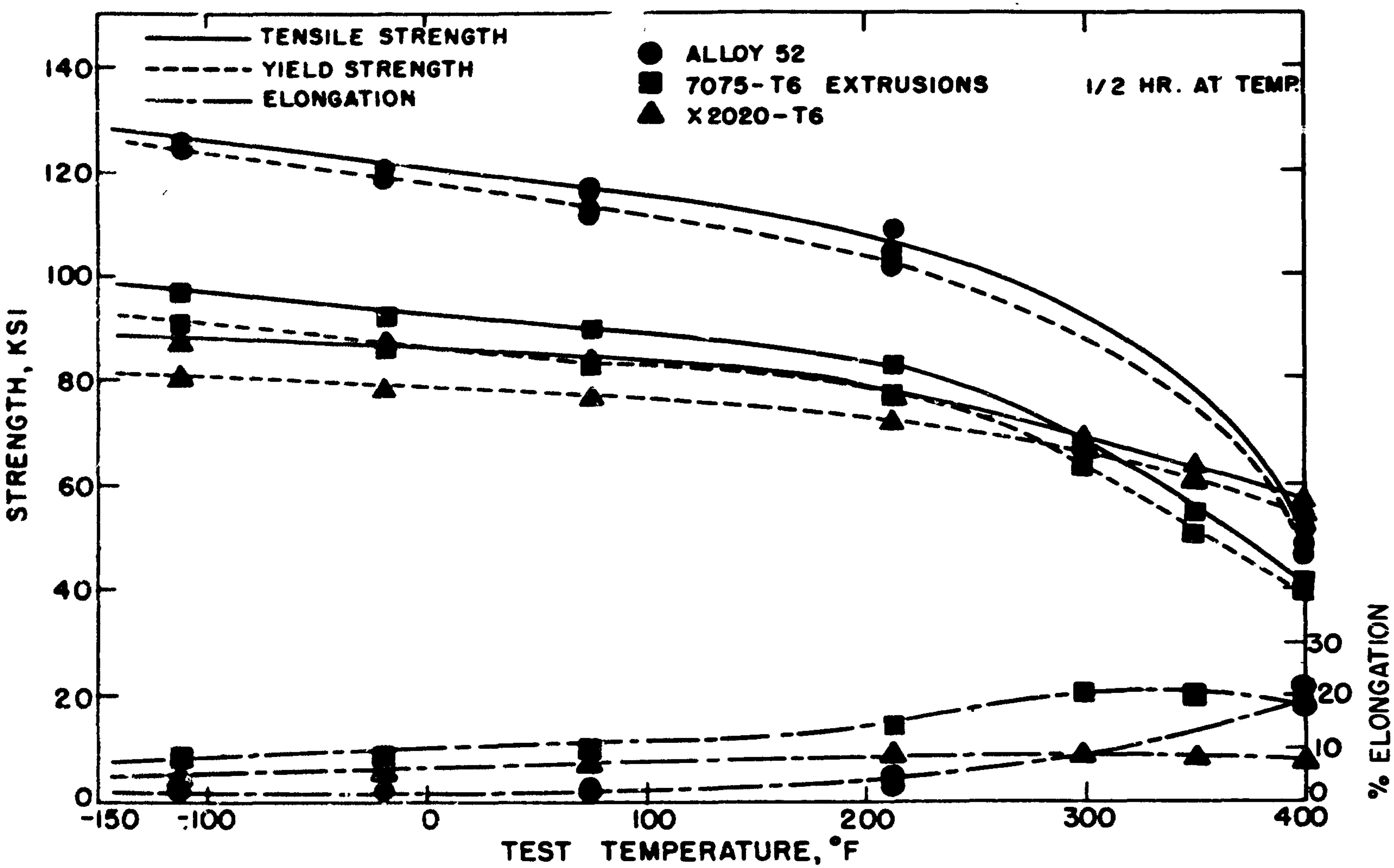


FIGURE 3

LONGITUDINAL TENSILE PROPERTIES OF ALLOYS AT CRYOGENIC AND ELEVATED TEMPERATURES

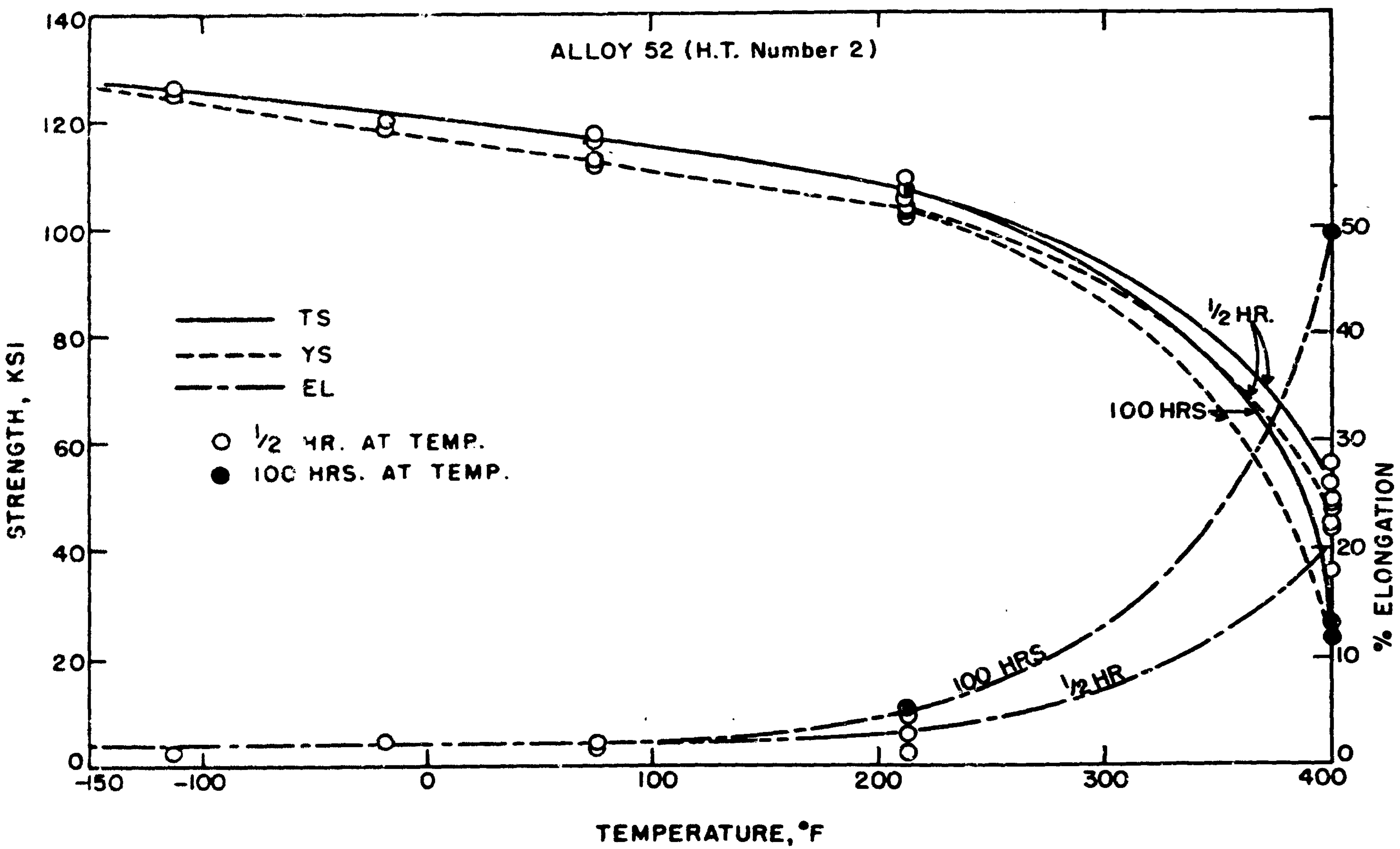


FIGURE 4

THE EFFECT OF TIME AT TEMPERATURE ON LONGITUDINAL TENSILE PROPERTIES

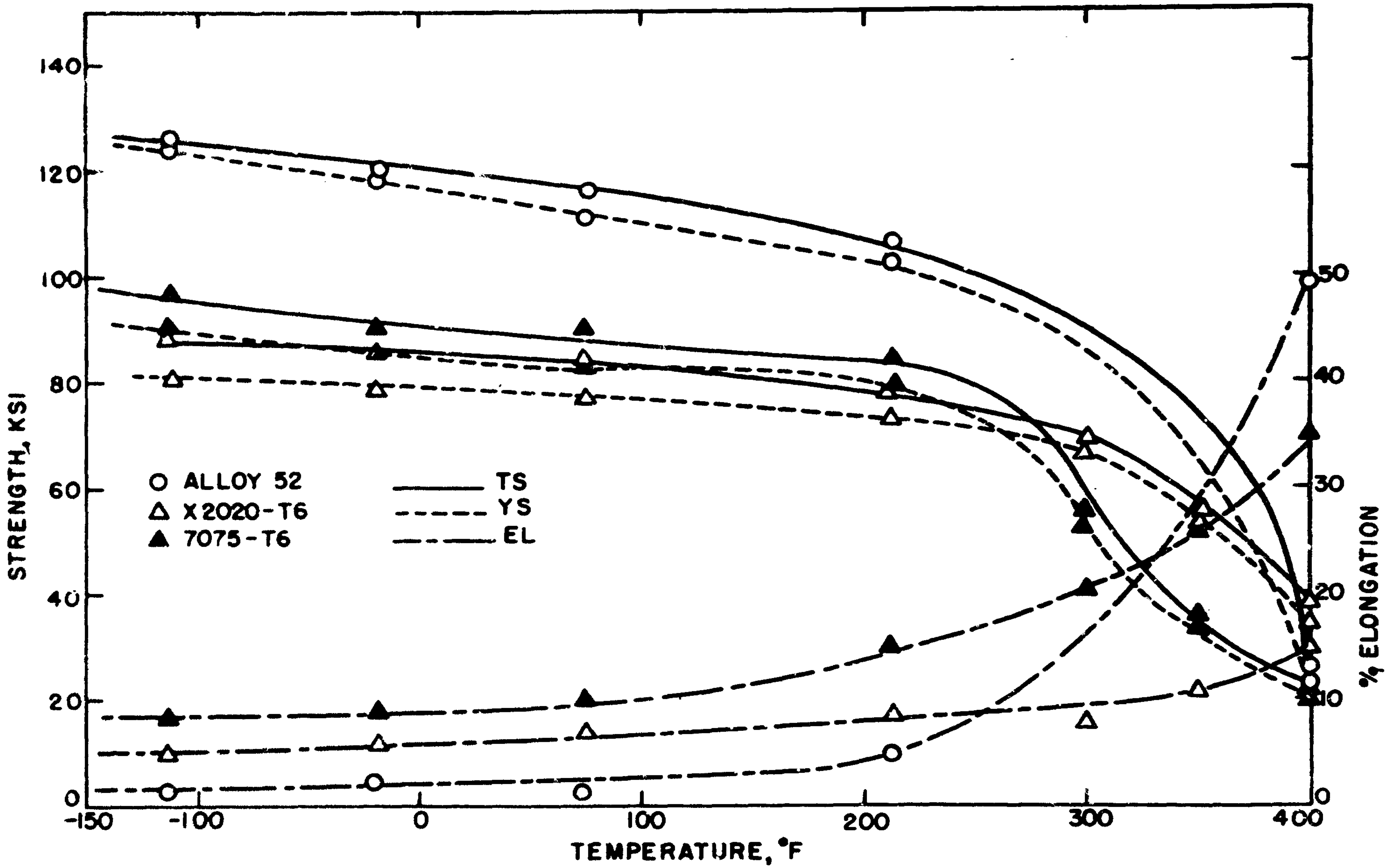
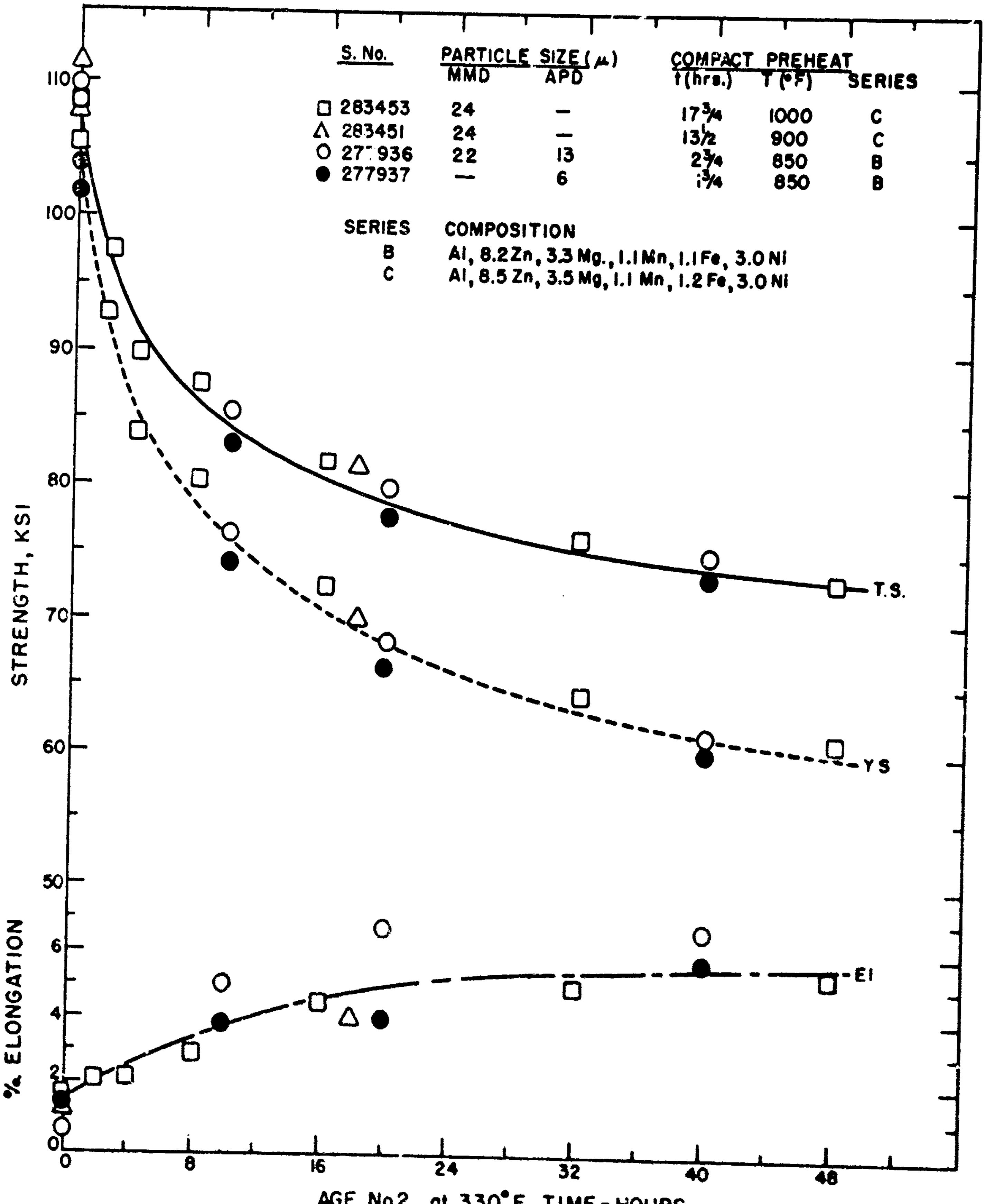


FIGURE 5

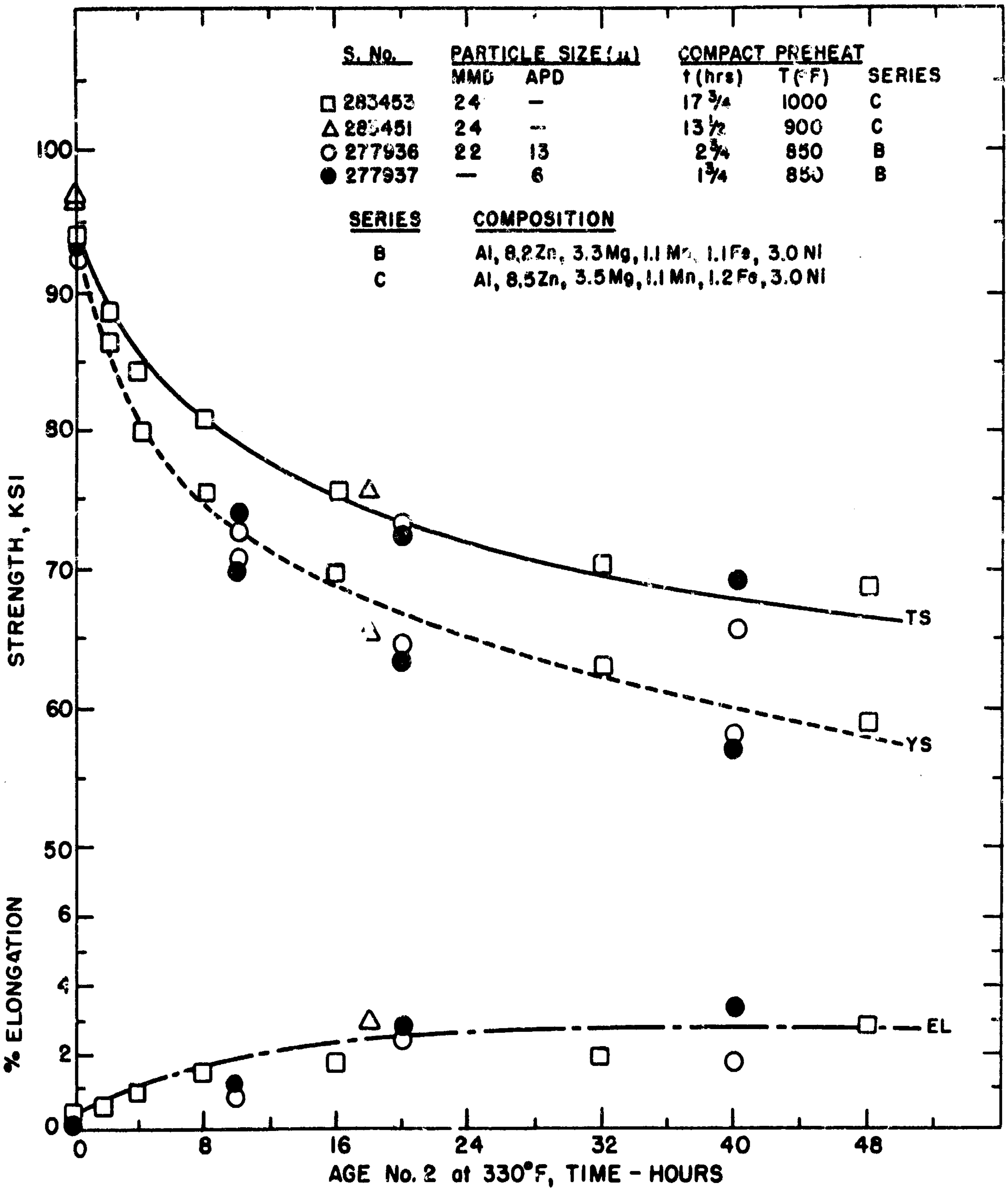
LONGITUDINAL TENSILE PROPERTIES AFTER 100 HOURS AT TEMPERATURE



(All specimens SHT 2 hours at 860°F, CWQ, Age number 1, 24 hours at 250°F)

FIGURE 6

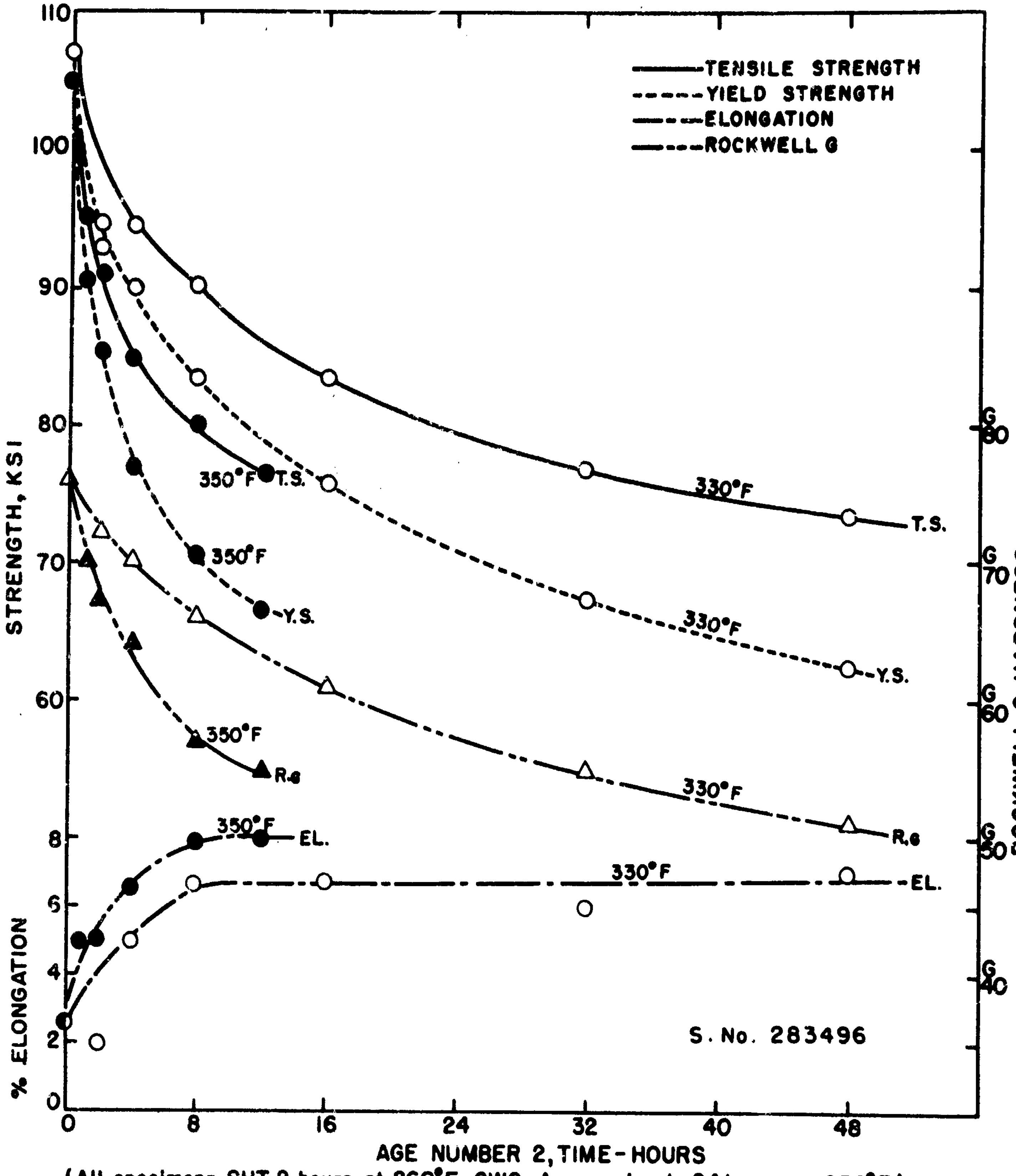
THE EFFECT OF STEP AGING ON ALLOY 38 - LONGITUDINAL



(All specimens SHT 2 hours at 860°F, CWQ, Age number 1 24 hours at 250°F)

FIGURE 7

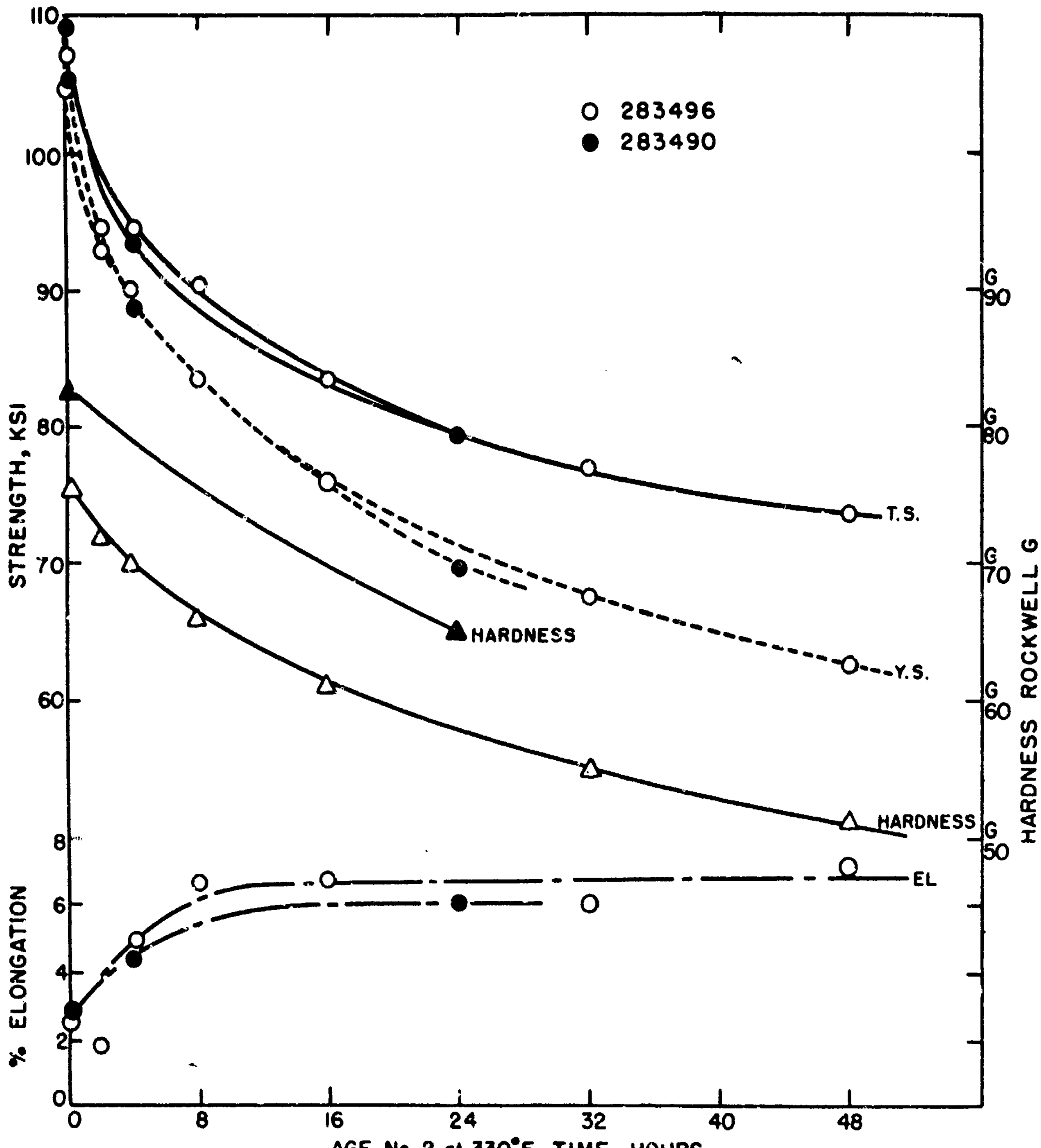
THE EFFECT OF STEP AGING ON ALLOY 38 - TRANSVERSE



(All specimens SHT 2 hours at 860°F, CWQ, Age number I, 24 hours at 250°F)

FIGURE 8

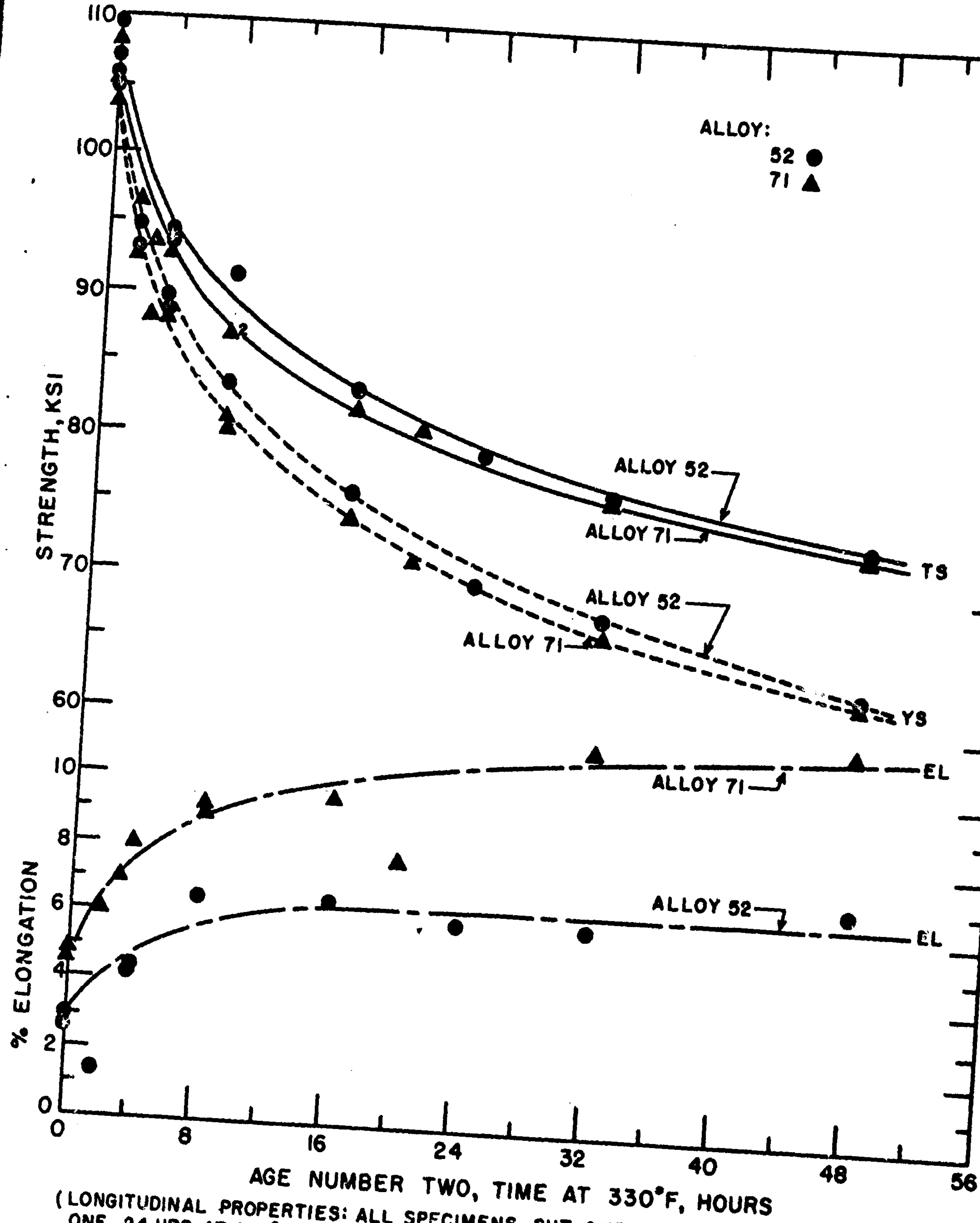
THE EFFECT OF STEP AGING ON ALLOY 52 - LONGITUDINAL



(All specimens SHT 2 hours at 860°F, CWQ, Age number I, 24 hours at 250°F)

FIGURE 9

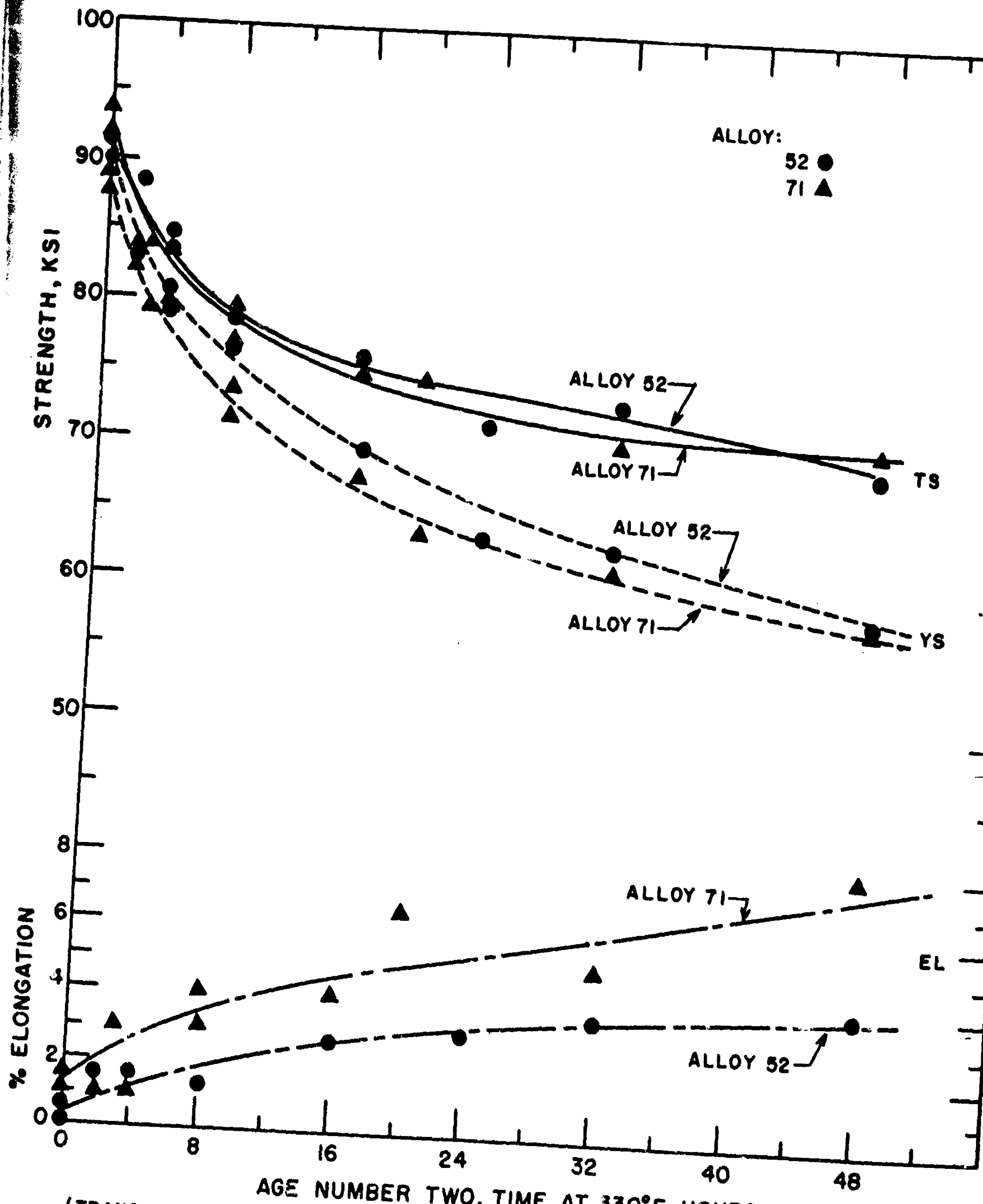
THE REPRODUCIBILITY OF STEP AGING ON ALLOY 52 - LONGITUDINAL



(LONGITUDINAL PROPERTIES: ALL SPECIMENS SHT 2 HRS AT 860°F, CWQ, AGE NUMBER ONE, 24 HRS AT 250°F.)

FIGURE 10

THE EFFECT OF STEP AGING ON ALLOYS 52 AND 71 - LONGITUDINAL



(TRANSVERSE PROPERTIES: ALL SPECIMENS SHT 2 HRS AT 860°F, CWQ, AGE NUMBER ONE, 24 HRS AT 250°F)

FIGURE 11
THE EFFECT OF STEP AGING ON ALLOYS 52 AND 71 - TRANSVERSE

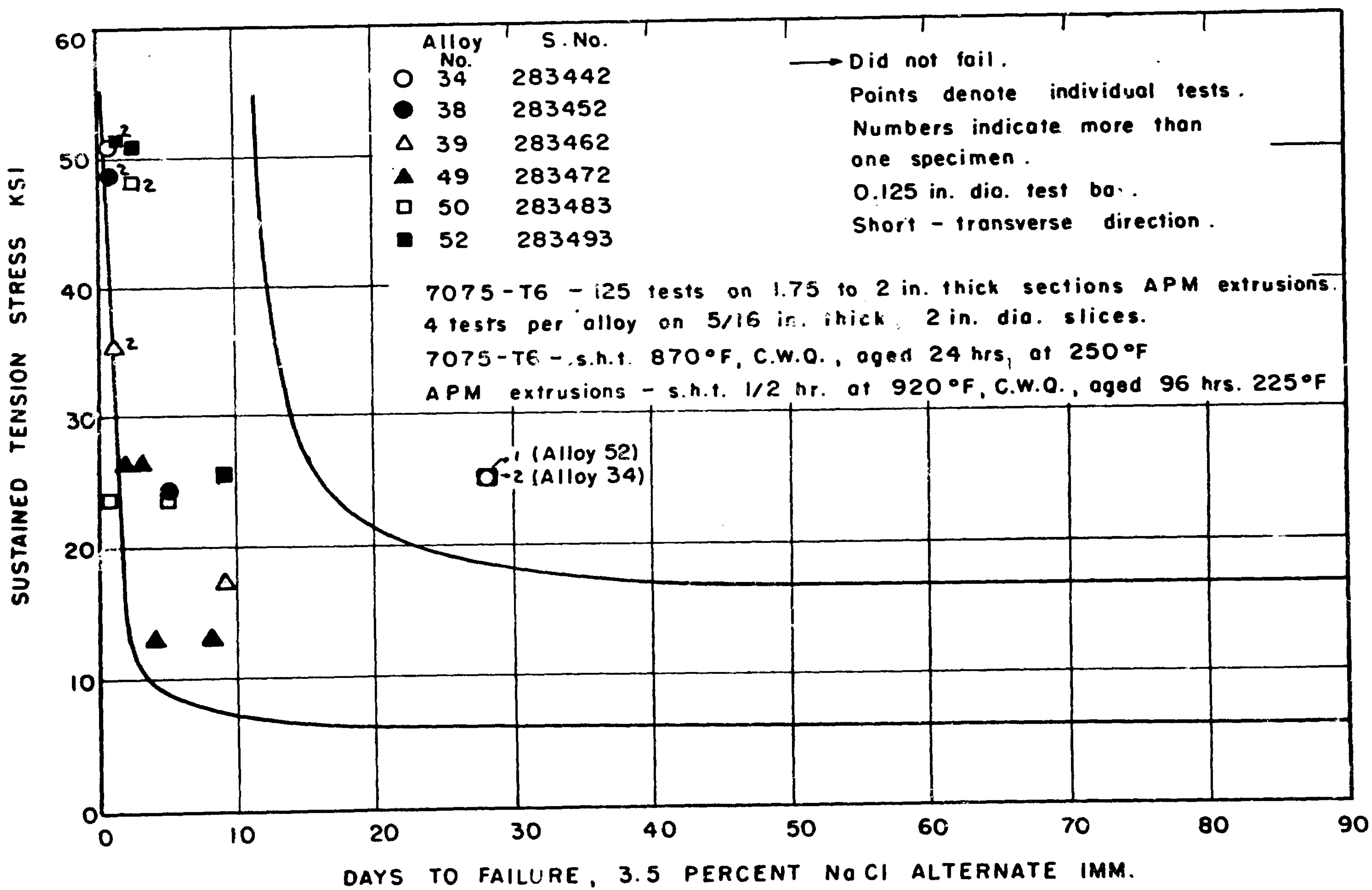


FIGURE 12

COMPARISON OF RELATIVE RESISTANCE TO STRESS-CORROSION CRACKING OF ALUMINUM POWDER METALLURGY EXTRUSIONS AND 7075-T6 EXTRUDED SECTIONS

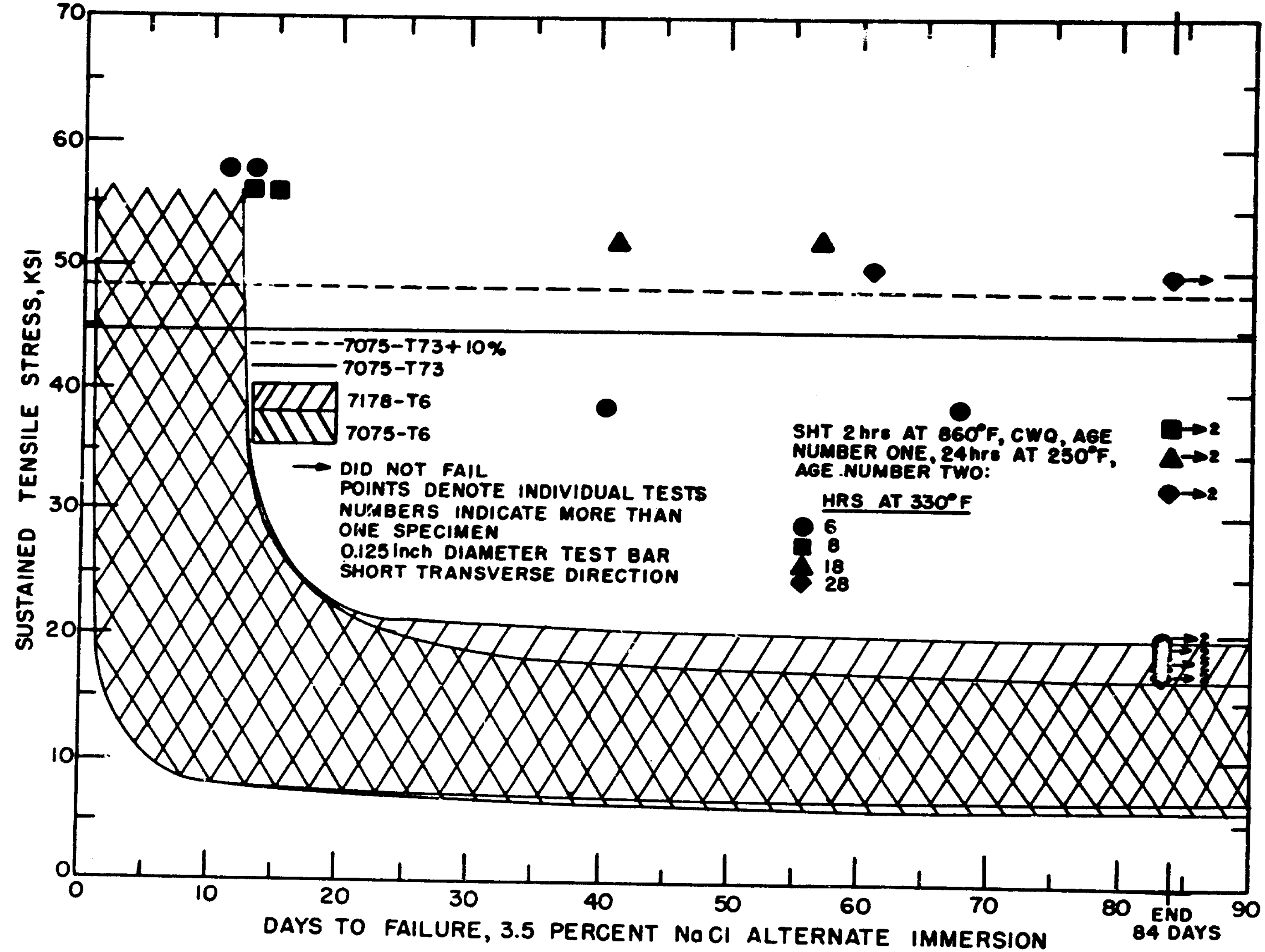


FIGURE 13
COMPARISON OF AGE NUMBER TWO ON RELATIVE RESISTANCE TO STRESS CORROSION CRACKING FOR ALLOY 2

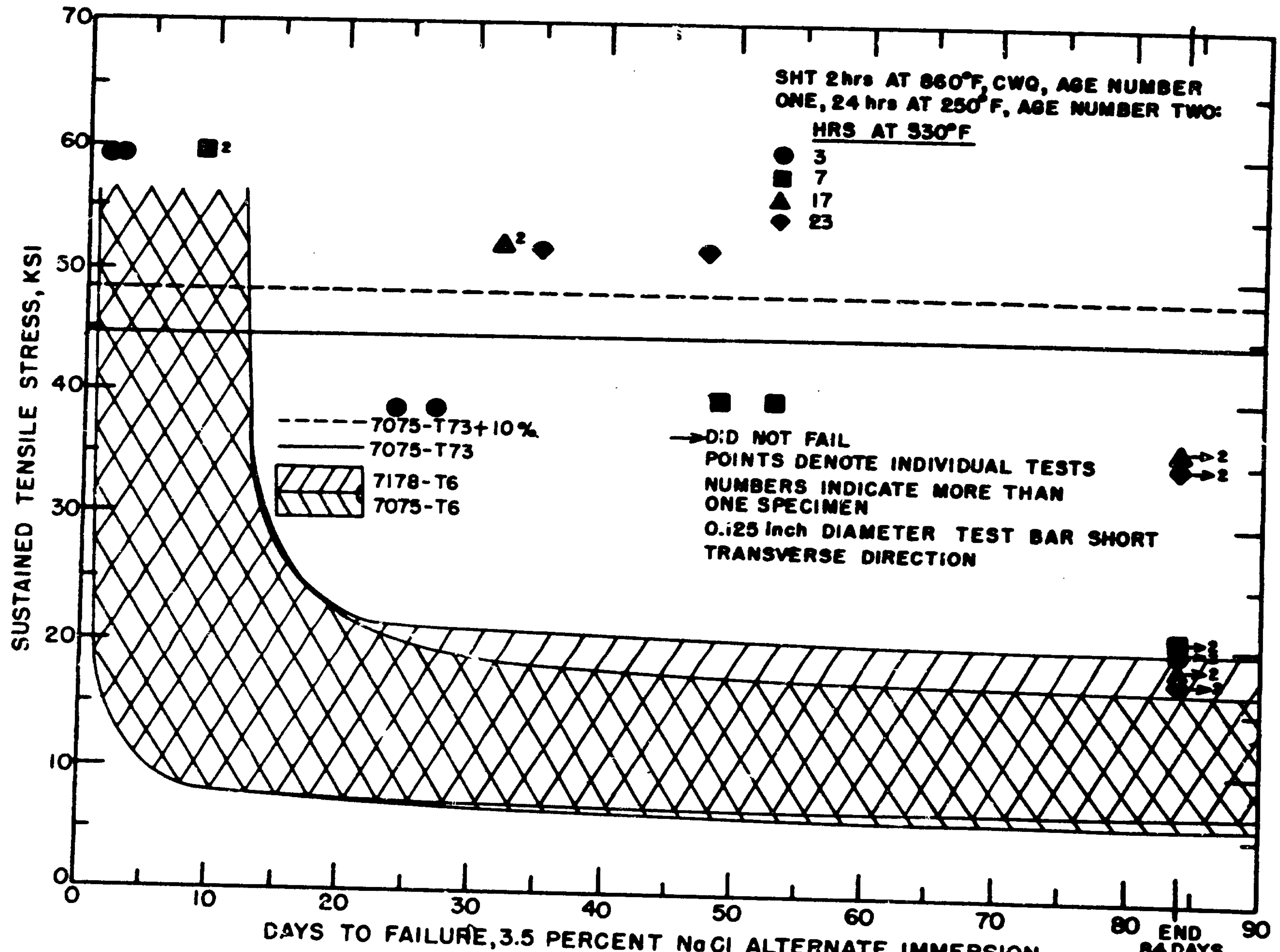


FIGURE 14
COMPARISON OF AGE NUMBER TWO ON RELATIVE RESISTANCE TO STRESS CORROSION CRACKING FOR ALLOY 3

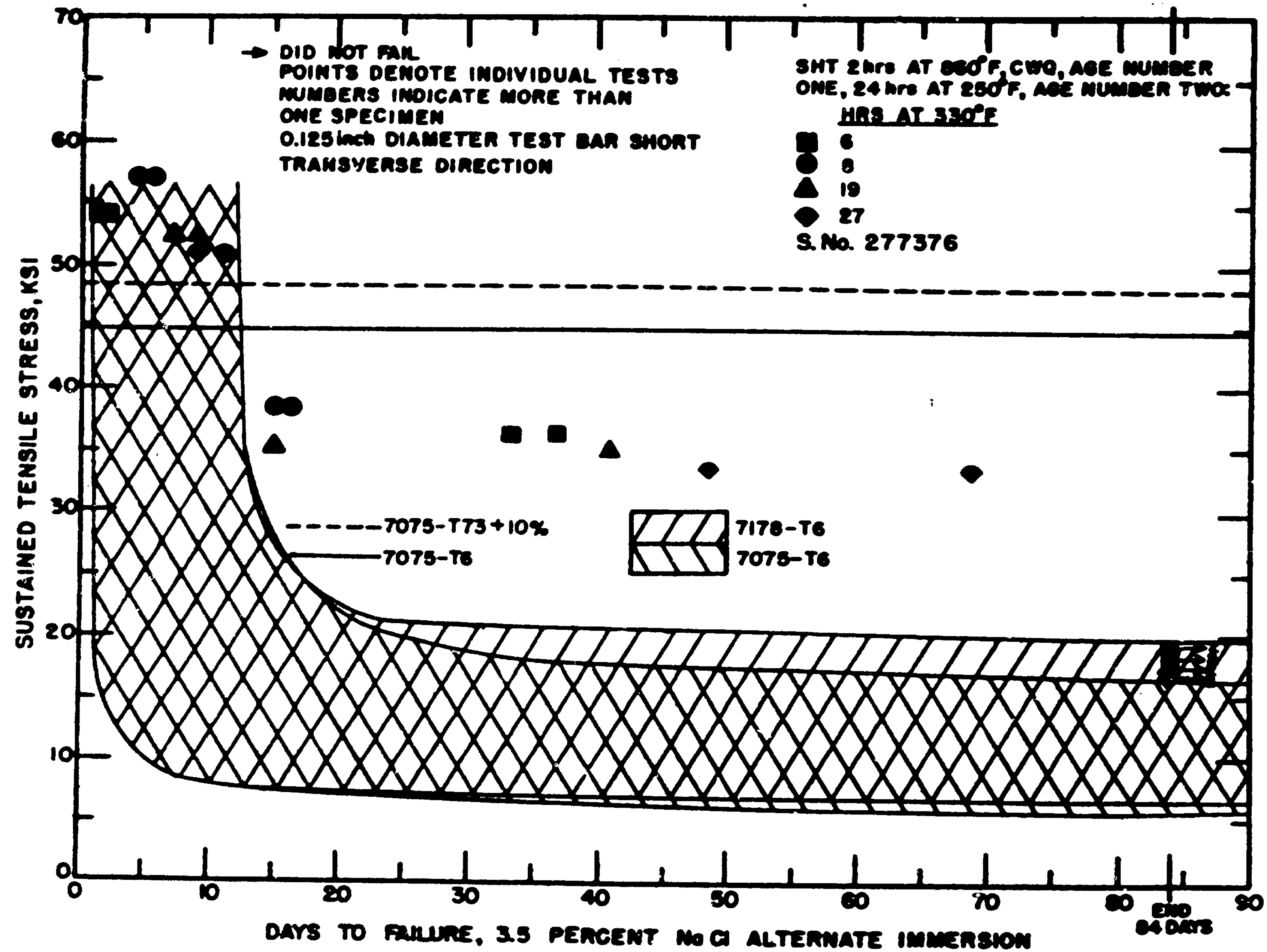


FIGURE 15
COMPARISON OF AGE NUMBER TWO ON RELATIVE RESISTANCE TO STRESS CORROSION CRACKING FOR ALLOY 4

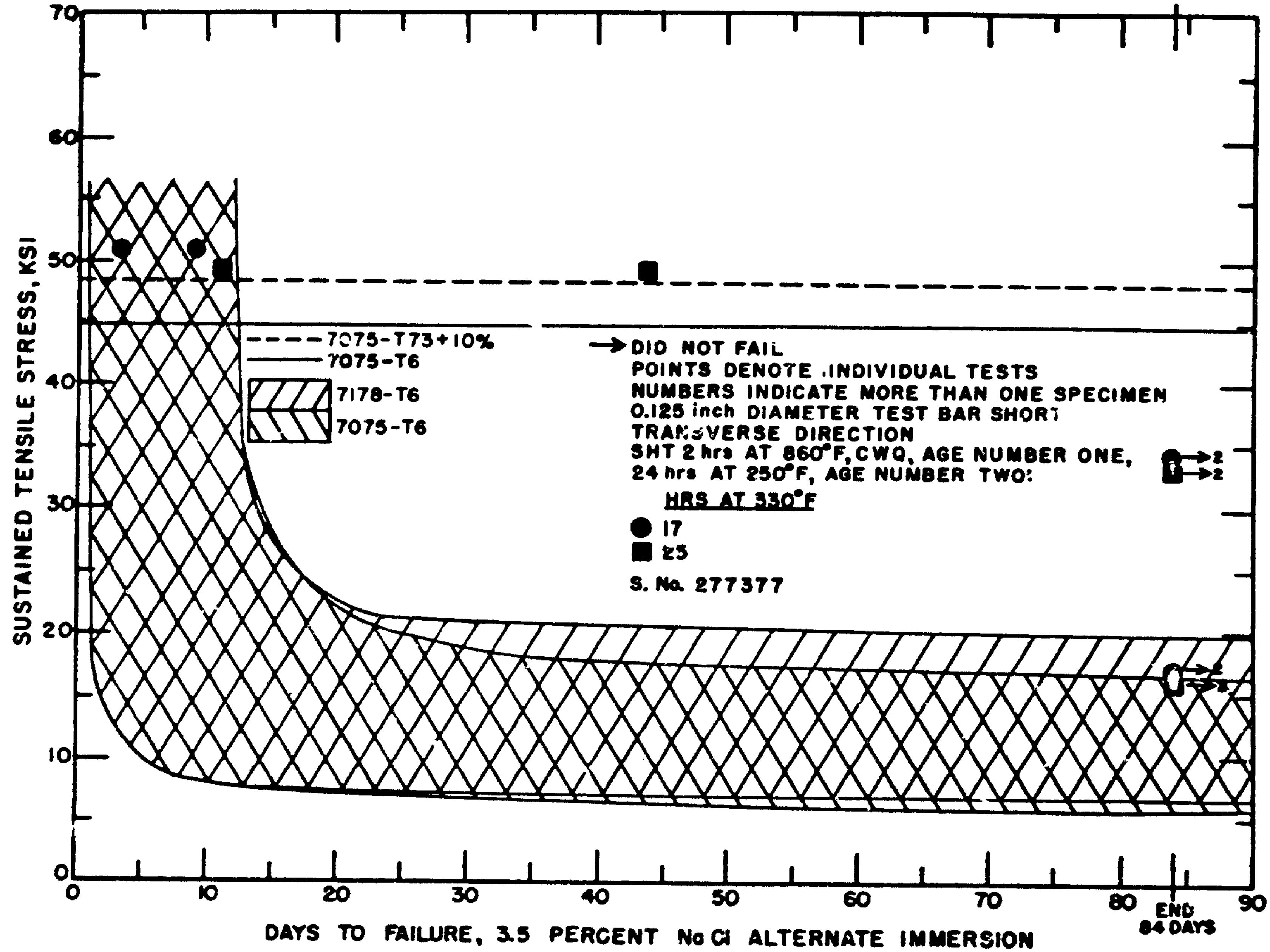


FIGURE 16
COMPARISON OF AGE NUMBER TWO ON RELATIVE RESISTANCE TO STRESS CORROSION CRACKING FOR ALLOY 5

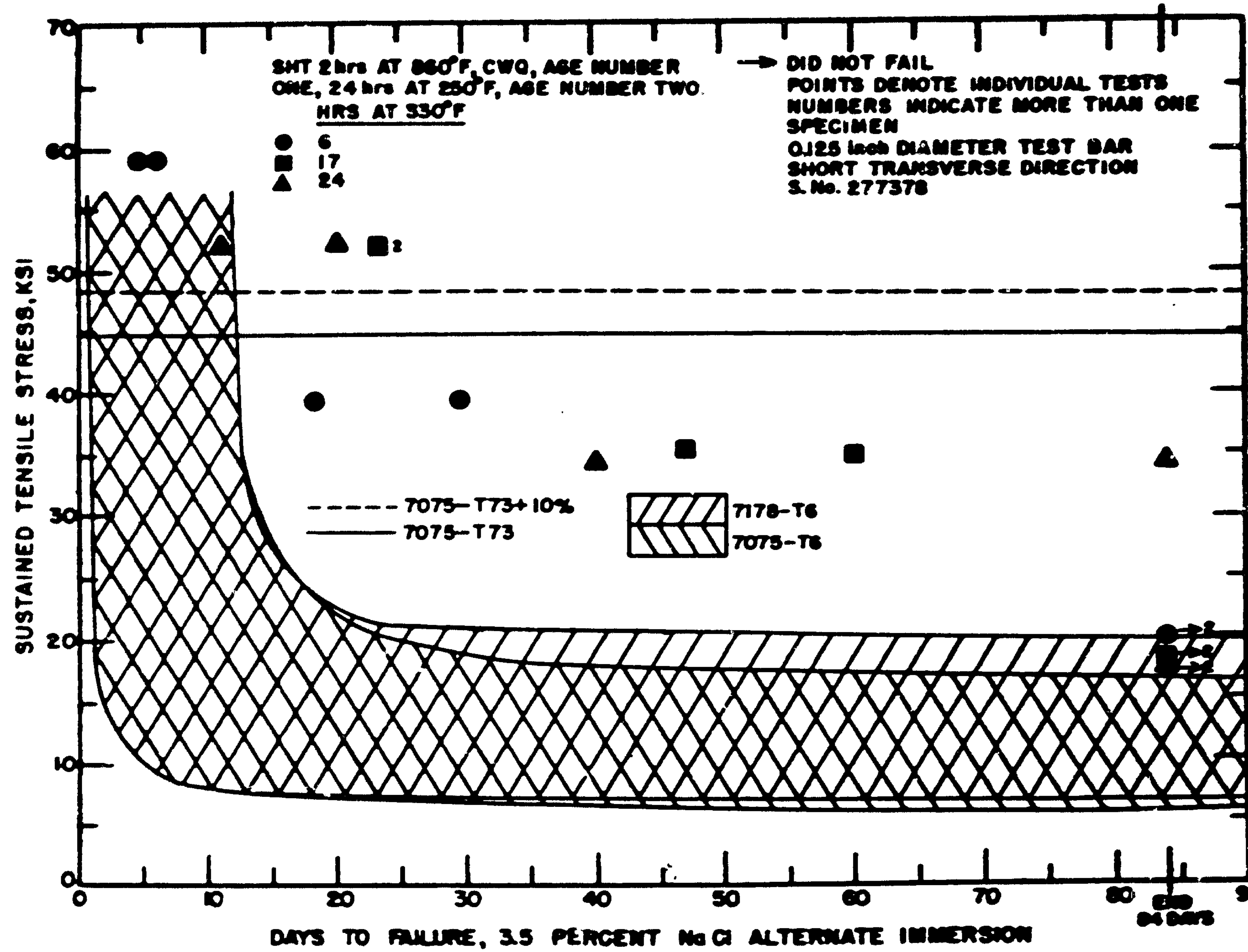


FIGURE 17
COMPARISON OF AGE NUMBER TWO ON RELATIVE RESISTANCE TO STRESS CORROSION CRACKING FOR ALLOY 6

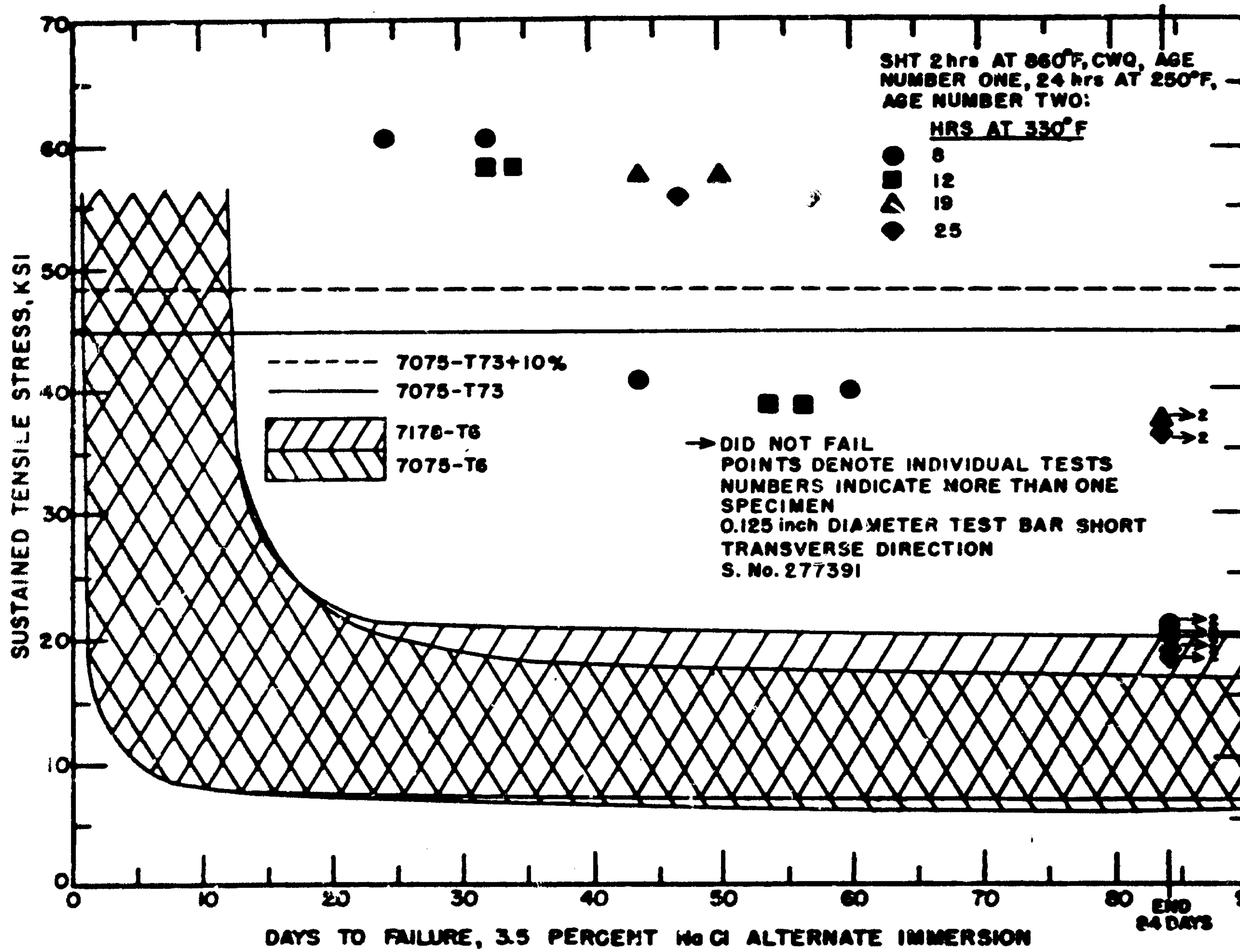


FIGURE 18
COMPARISON OF AGE NUMBER TWO ON RELATIVE RESISTANCE TO STRESS CORROSION CRACKING FOR ALLOY 19

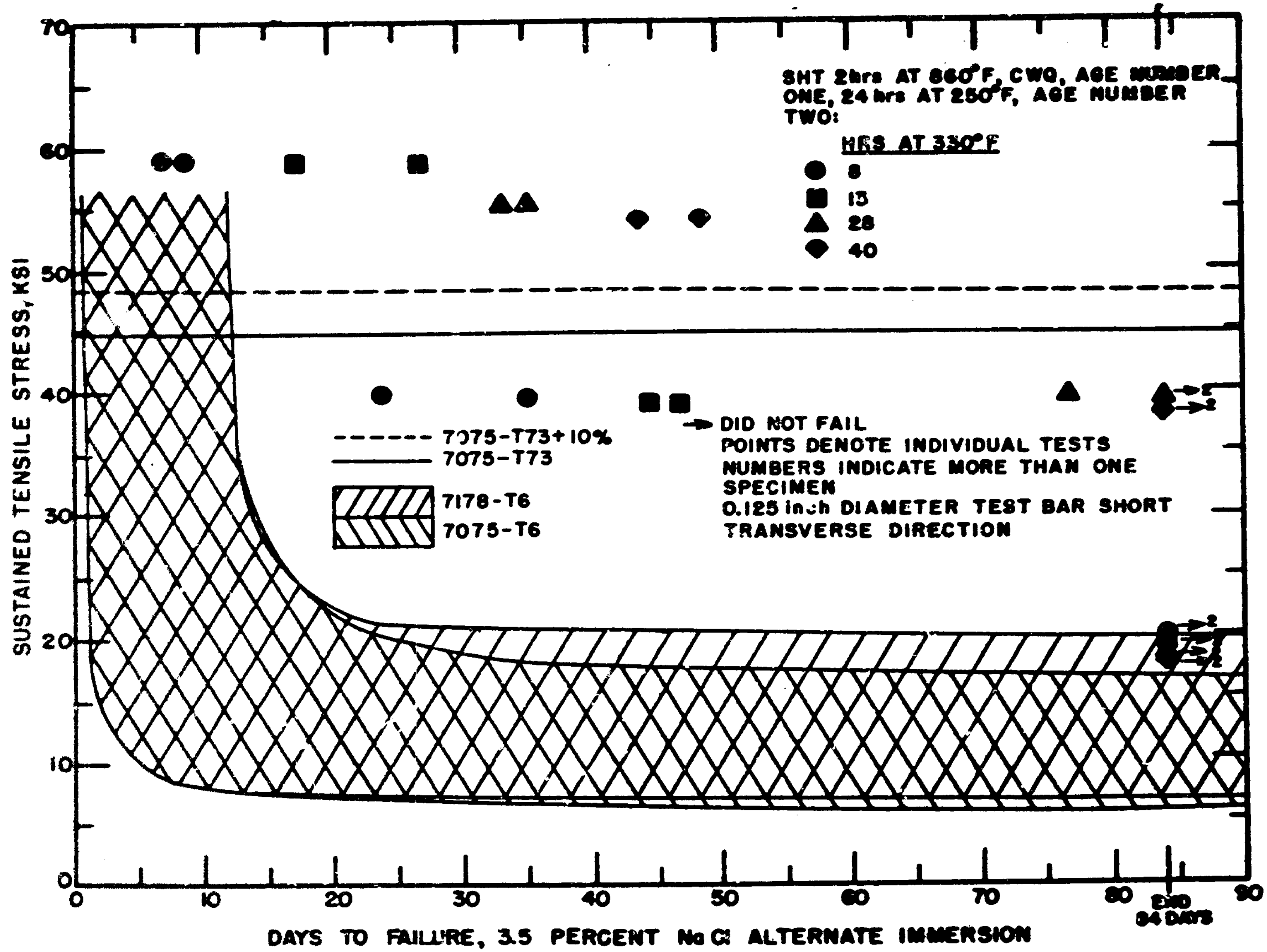


FIGURE 19
COMPARISON OF AGE NUMBER TWO ON RELATIVE RESISTANCE TO STRESS CORROSION CRACKING FOR ALLOY 20

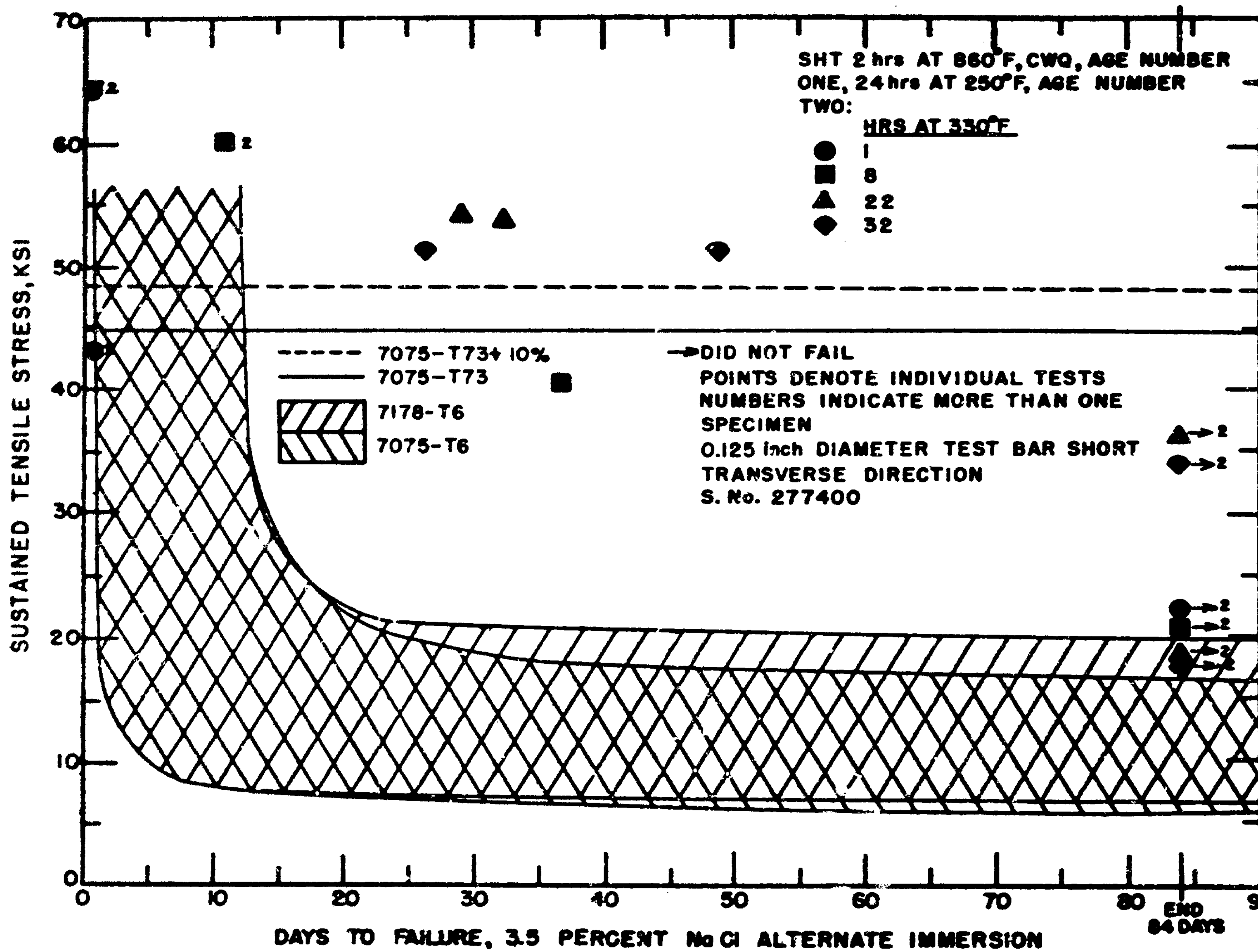


FIGURE 20
COMPARISON OF AGE NUMBER TWO ON RELATIVE RESISTANCE TO STRESS CORROSION CRACKING FOR ALLOY 28

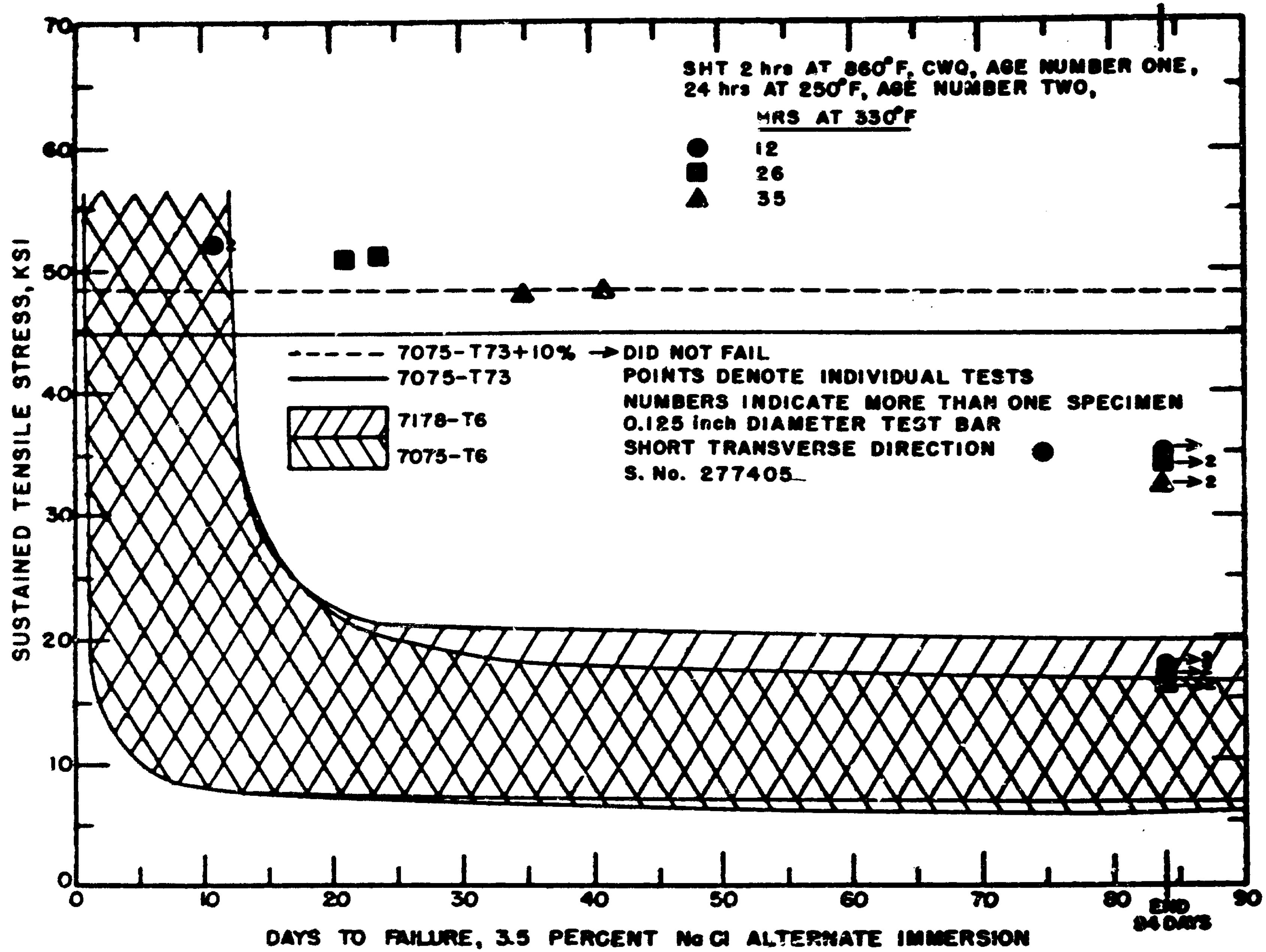


FIGURE 21
COMPARISON OF AGE NUMBER TWO ON RELATIVE RESISTANCE TO STRESS CORROSION CRACKING FOR ALLOY 33

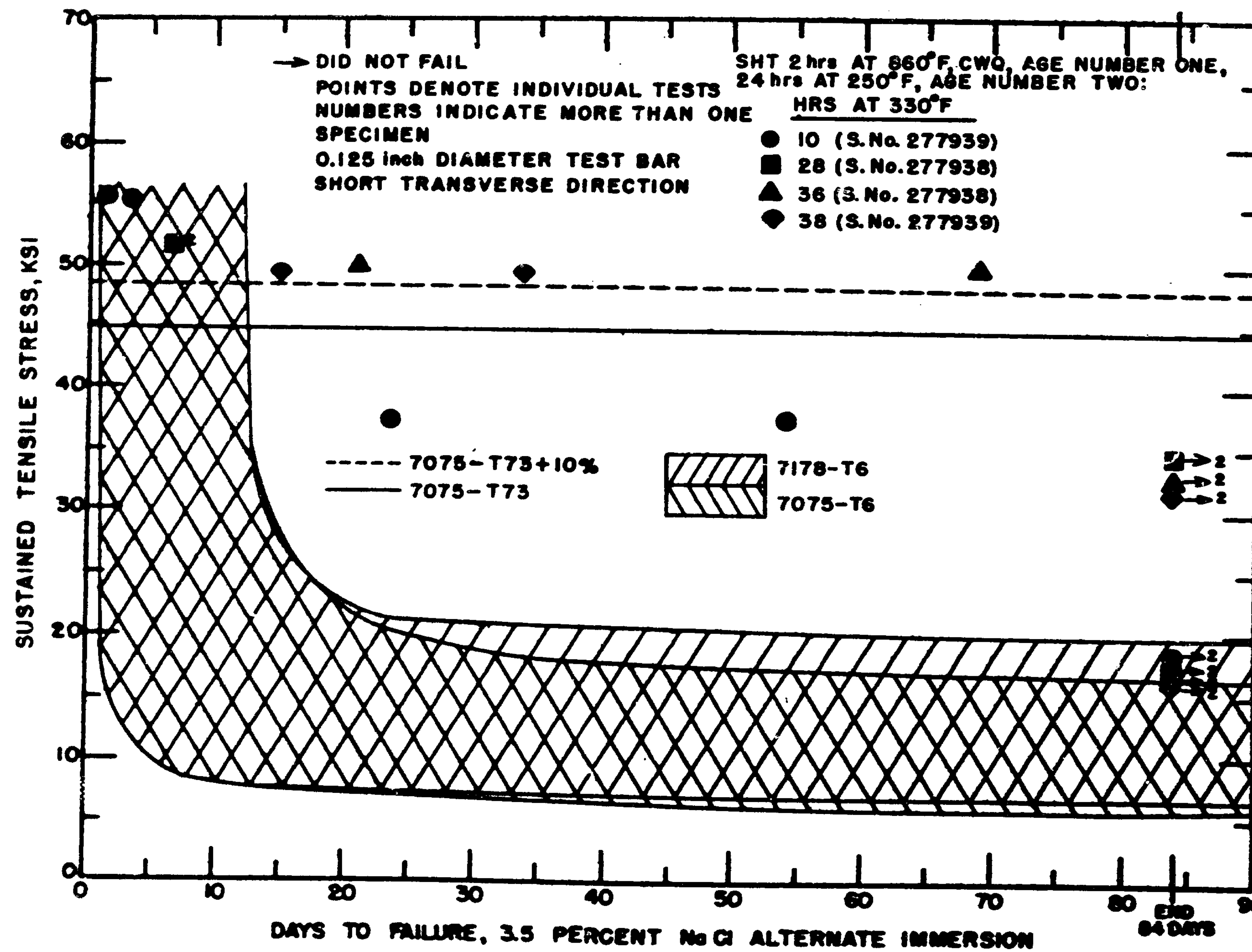


FIGURE 22
COMPARISON OF AGE NUMBER TWO ON RELATIVE RESISTANCE TO STRESS CORROSION CRACKING FOR ALLOY 36

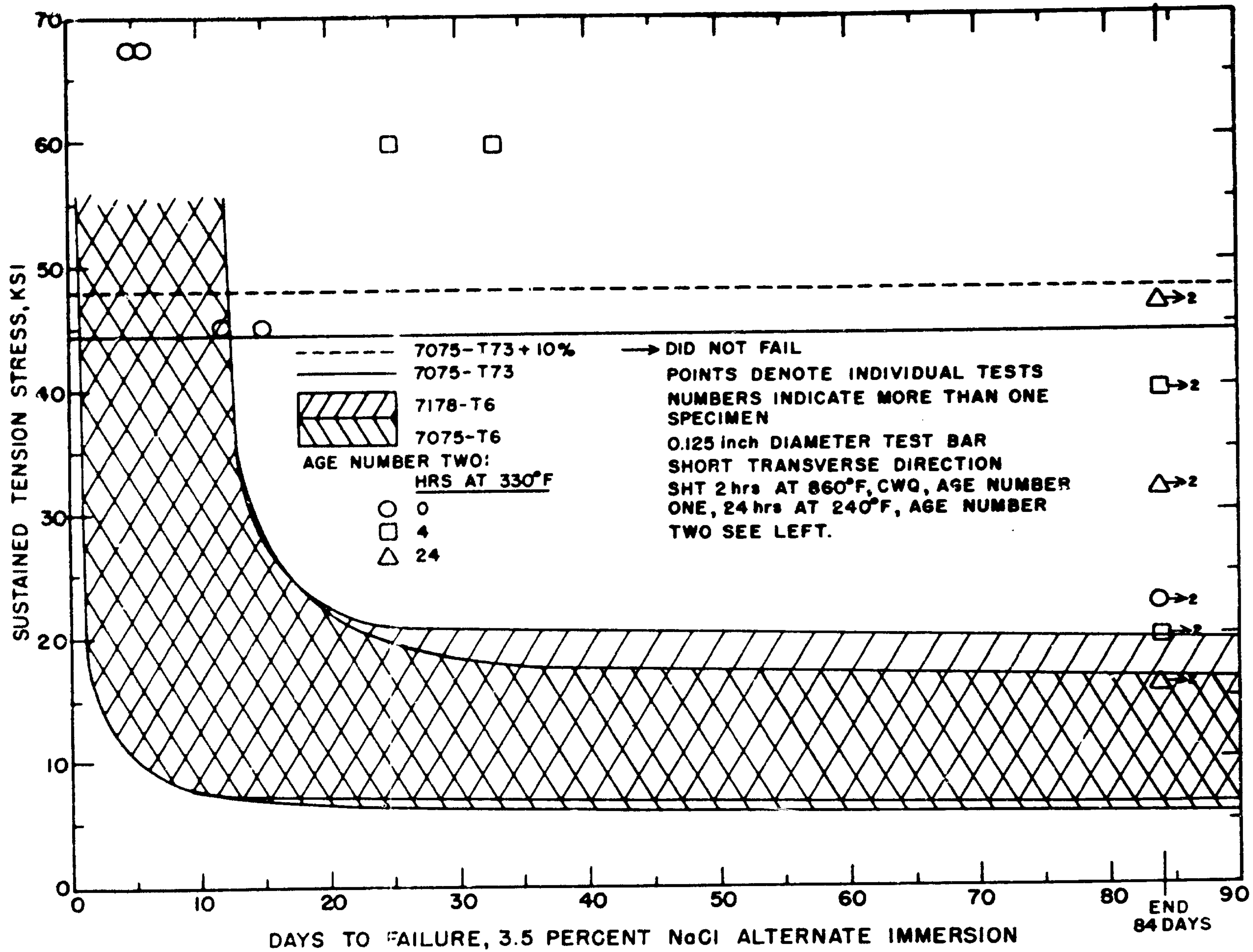


FIGURE 23

COMPARISON OF AGE NUMBER TWO ON RELATIVE RESISTANCE TO STRESS CORROSION CRACKING FOR ALLOY 52.

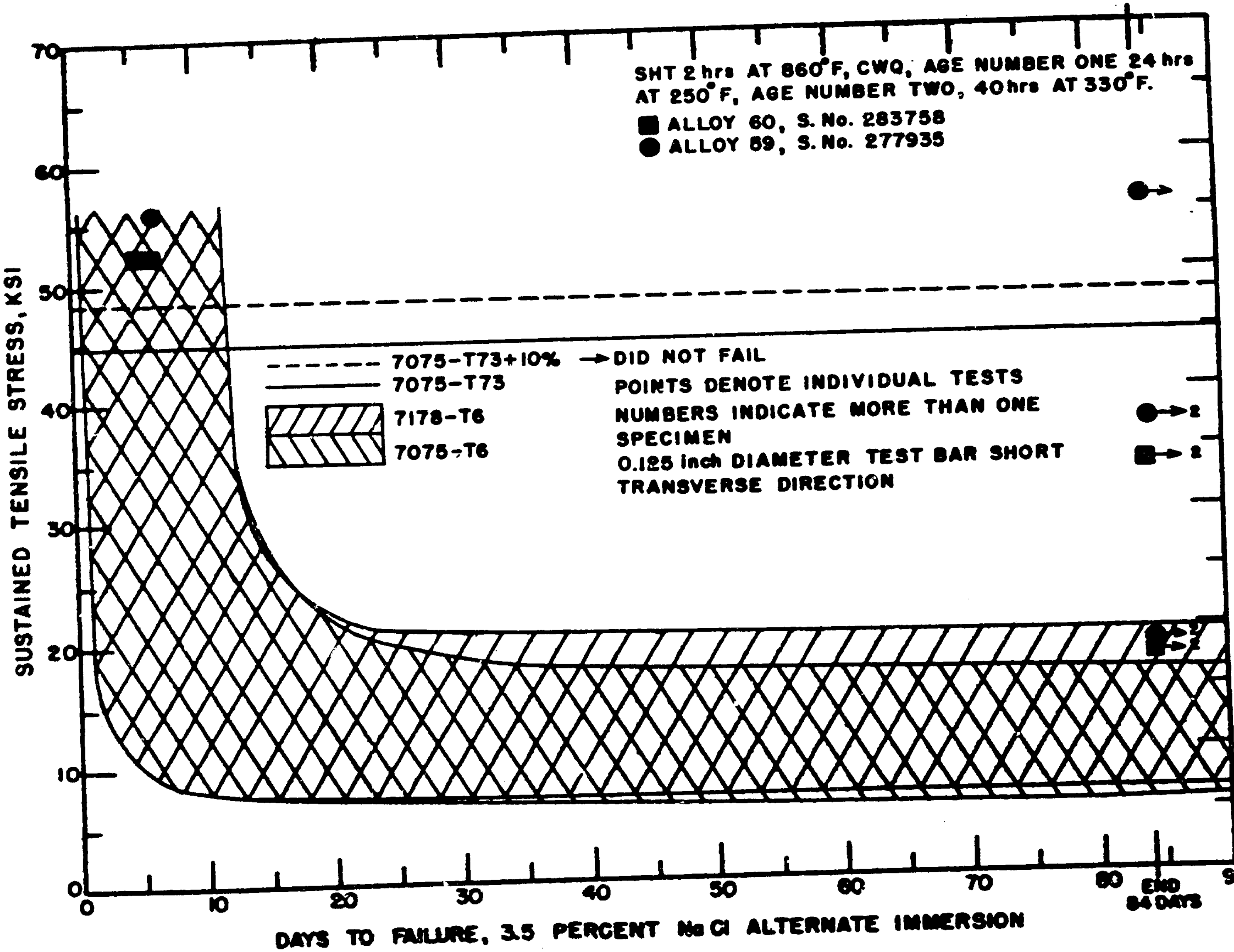


FIGURE 24
COMPARISON OF AGE NUMBER TWO ON RELATIVE RESISTANCE TO STRESS CORROSION CRACKING FOR ALLOYS 59 AND 60

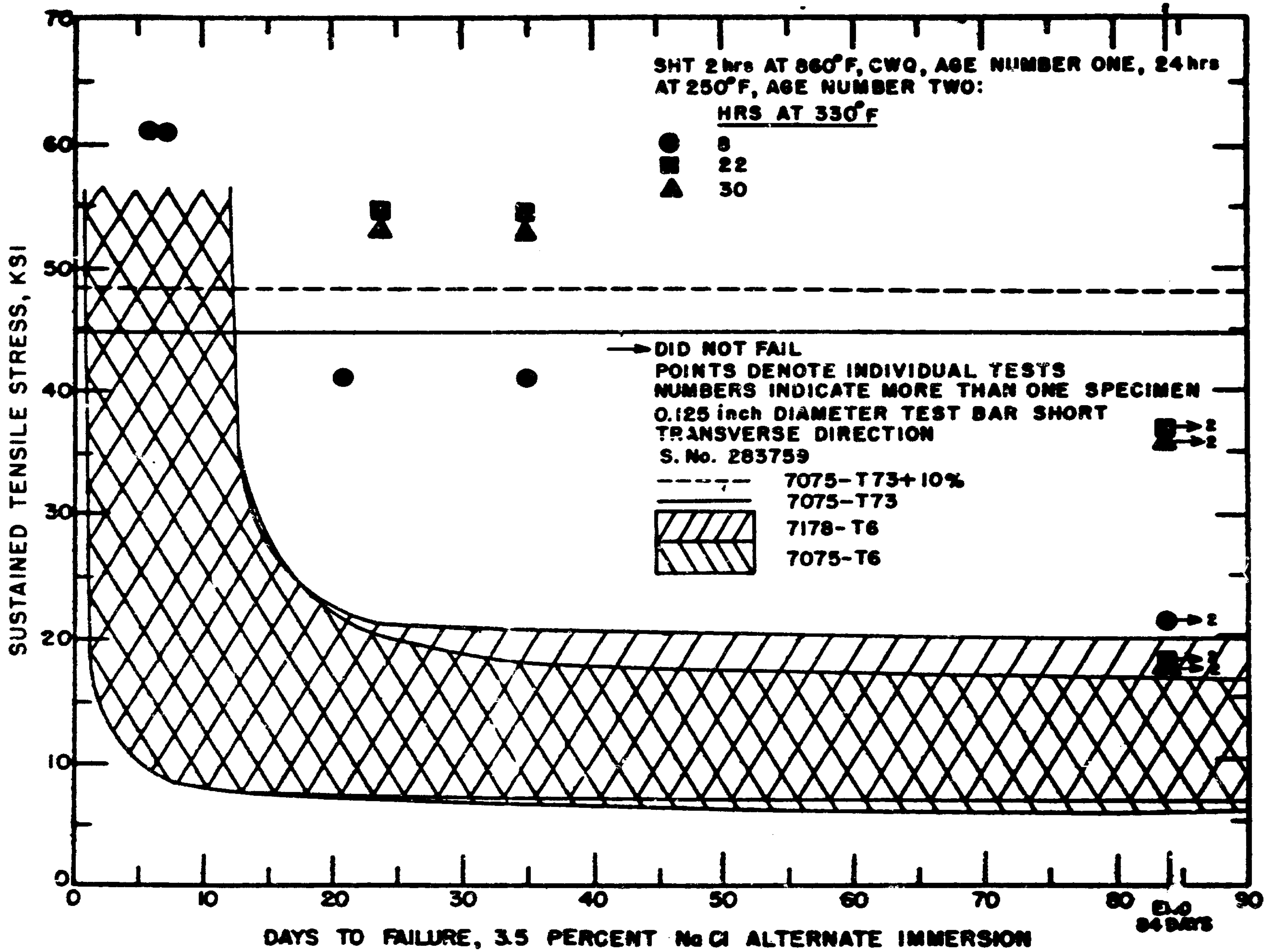


FIGURE 25
COMPARISON OF AGE NUMBER TWO ON RELATIVE RESISTANCE TO STRESS CORROSION CRACKING FOR ALLOY 61

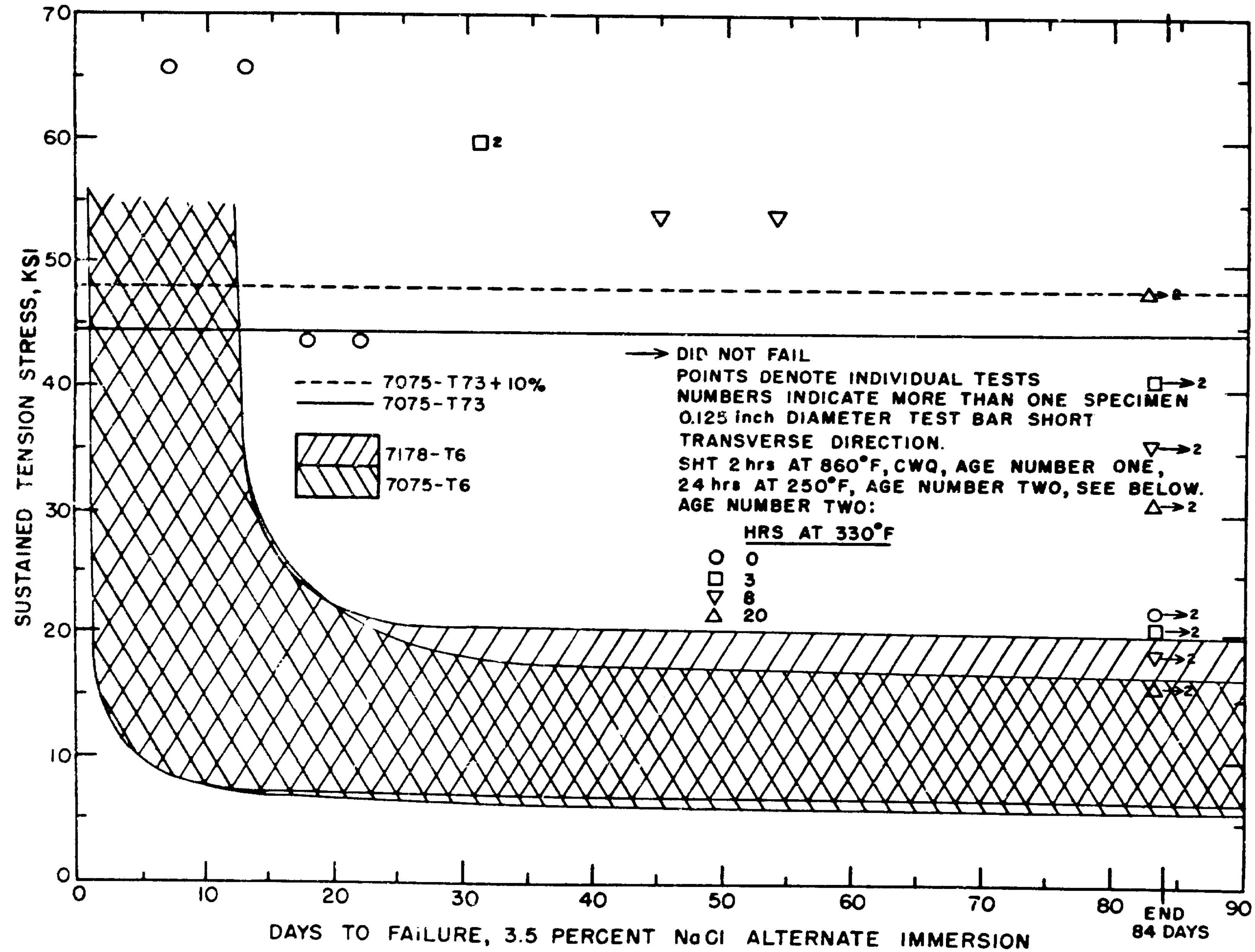


FIGURE 26

COMPARISON OF AGE NUMBER TWO ON RELATIVE RESISTANCE TO STRESS CORROSION CRACKING FOR ALLOY 71.

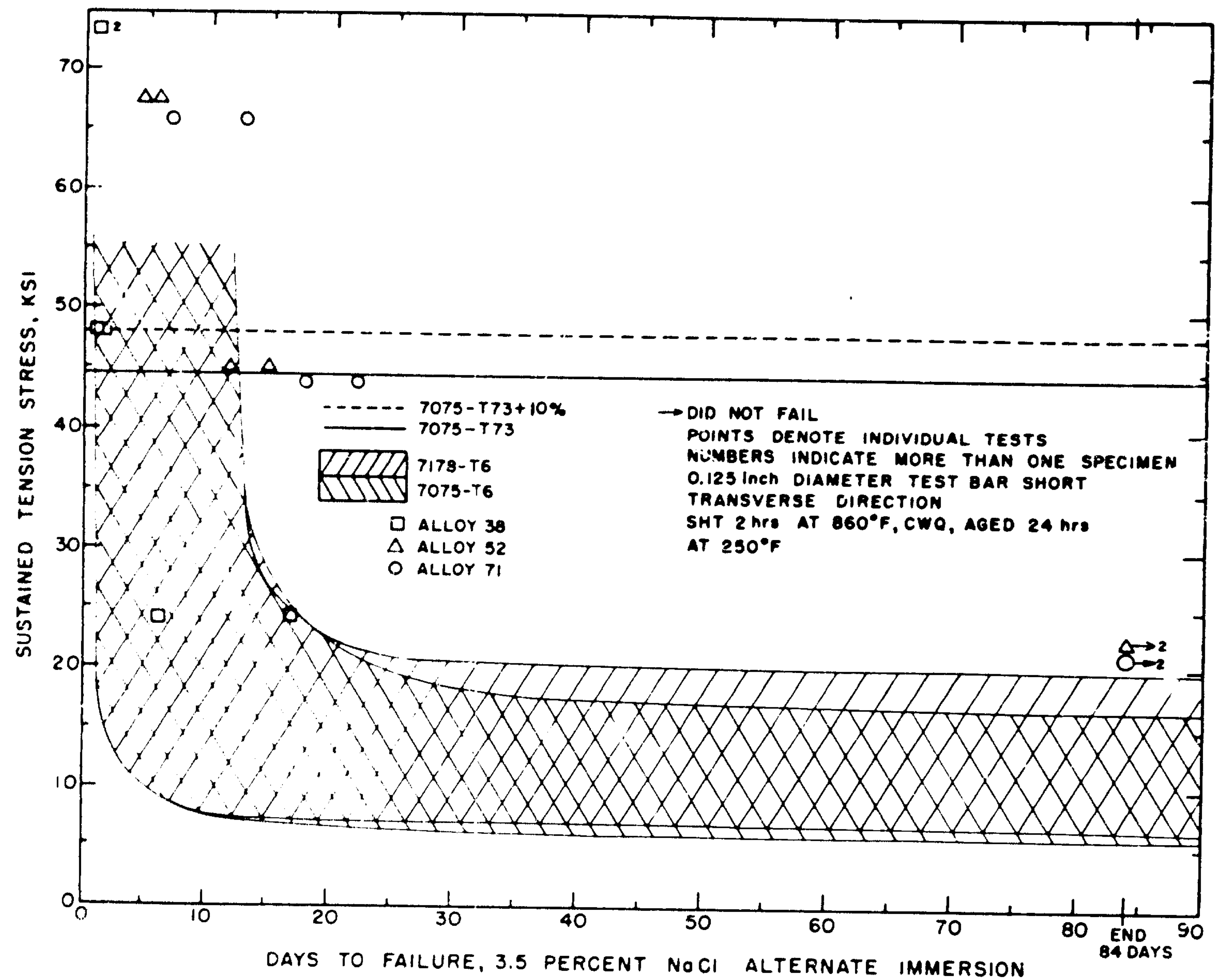


FIGURE 27

RELATIVE RESISTANCE OF APM ALLOYS 38, 52 AND 71 TO STRESS CORROSION CRACKING FOR TENSILE STRENGTHS OF APPROXIMATELY 10% GREATER THAN 7178-T6

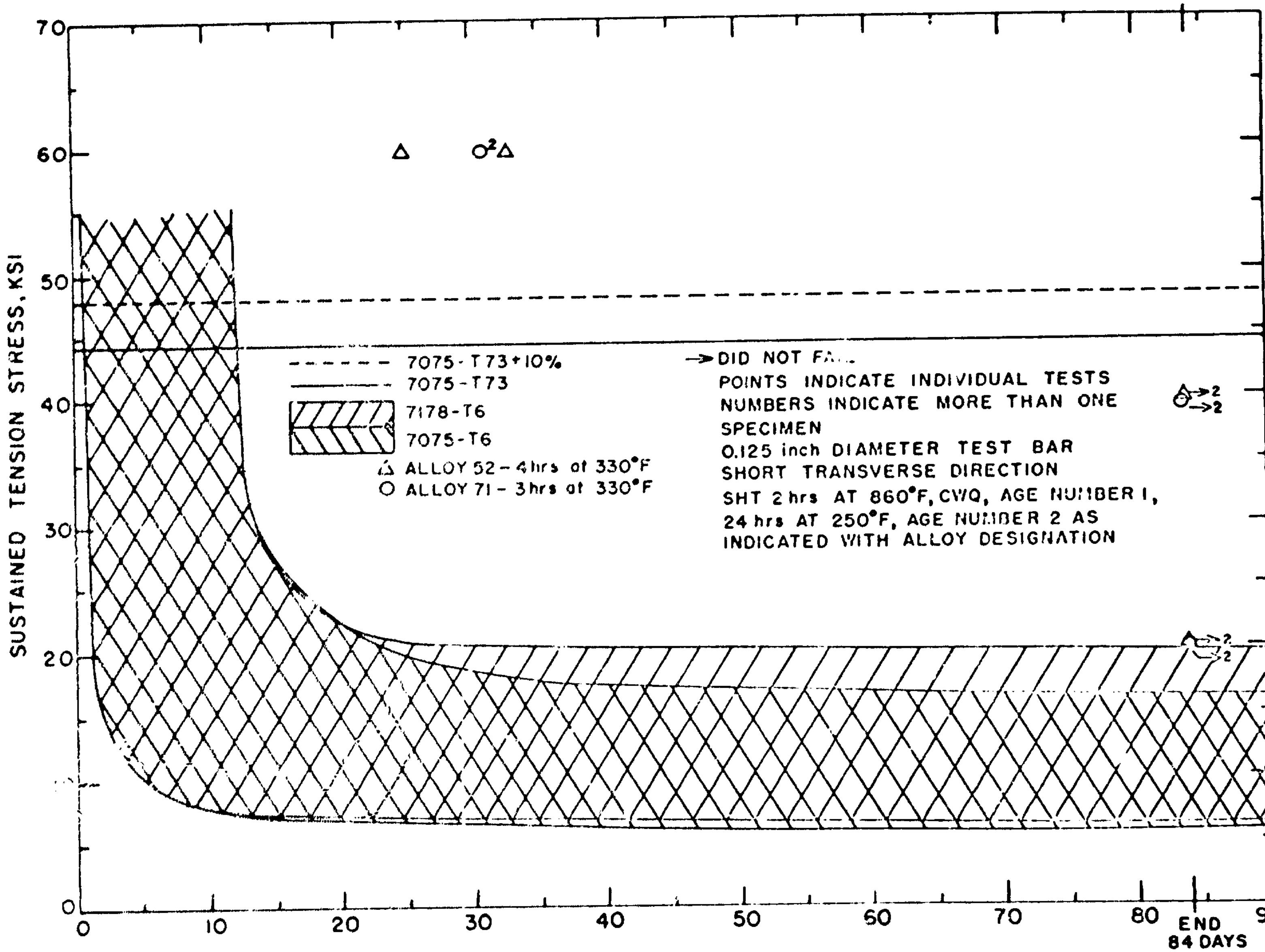


FIGURE 28

RELATIVE RESISTANCE OF APM ALLOYS 52 AND 71 TO STRESS CORROSION CRACKING FOR TENSILE STRENGTHS OF APPROXIMATELY 10% GREATER THAN 7075-T6

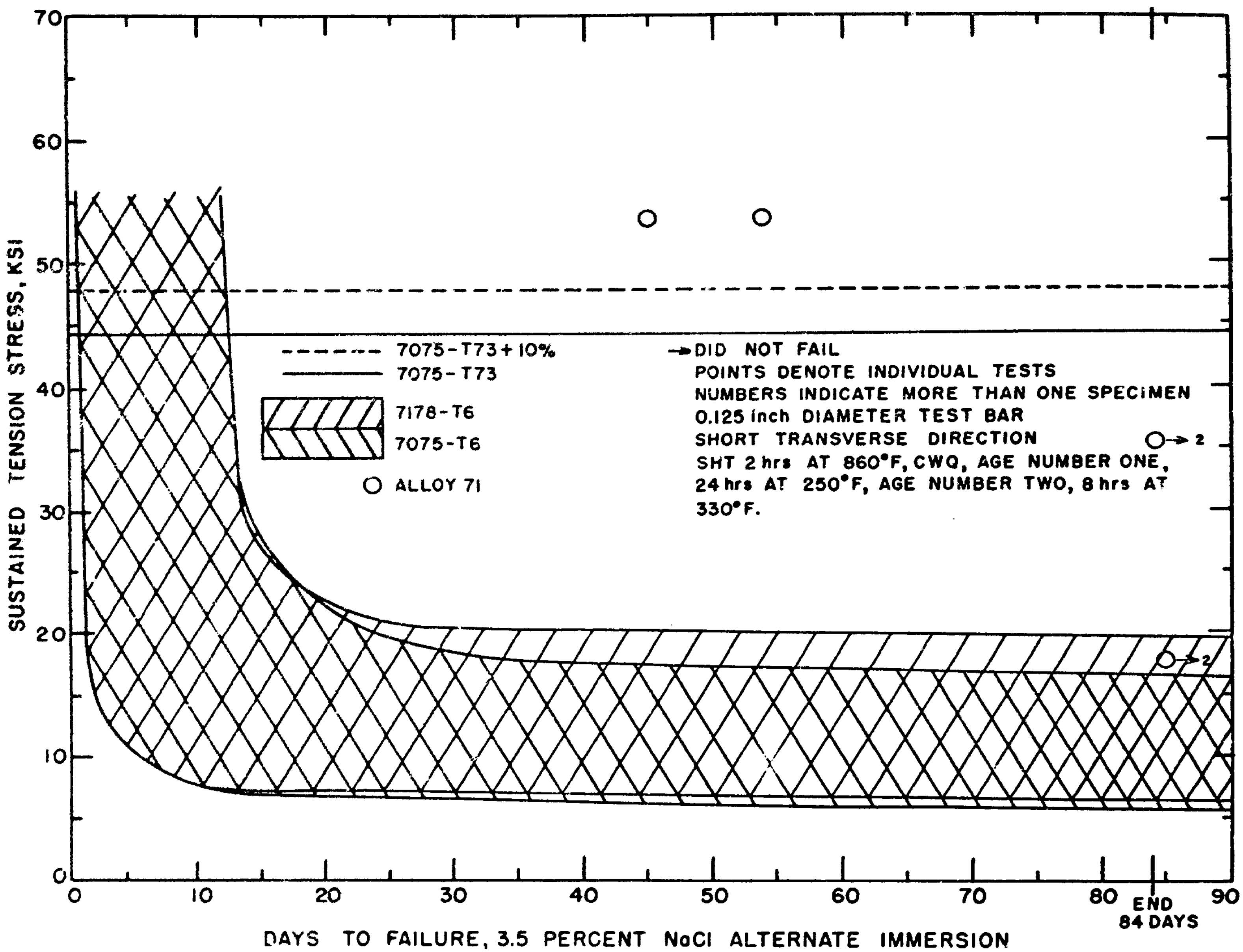


FIGURE 29

RELATIVE RESISTANCE OF APM ALLOY 71 TO STRESS CORROSION CRACKING FOR TENSILE STRENGTHS GREATER THAN 7075-T73 BUT LESS THAN 7075-T6

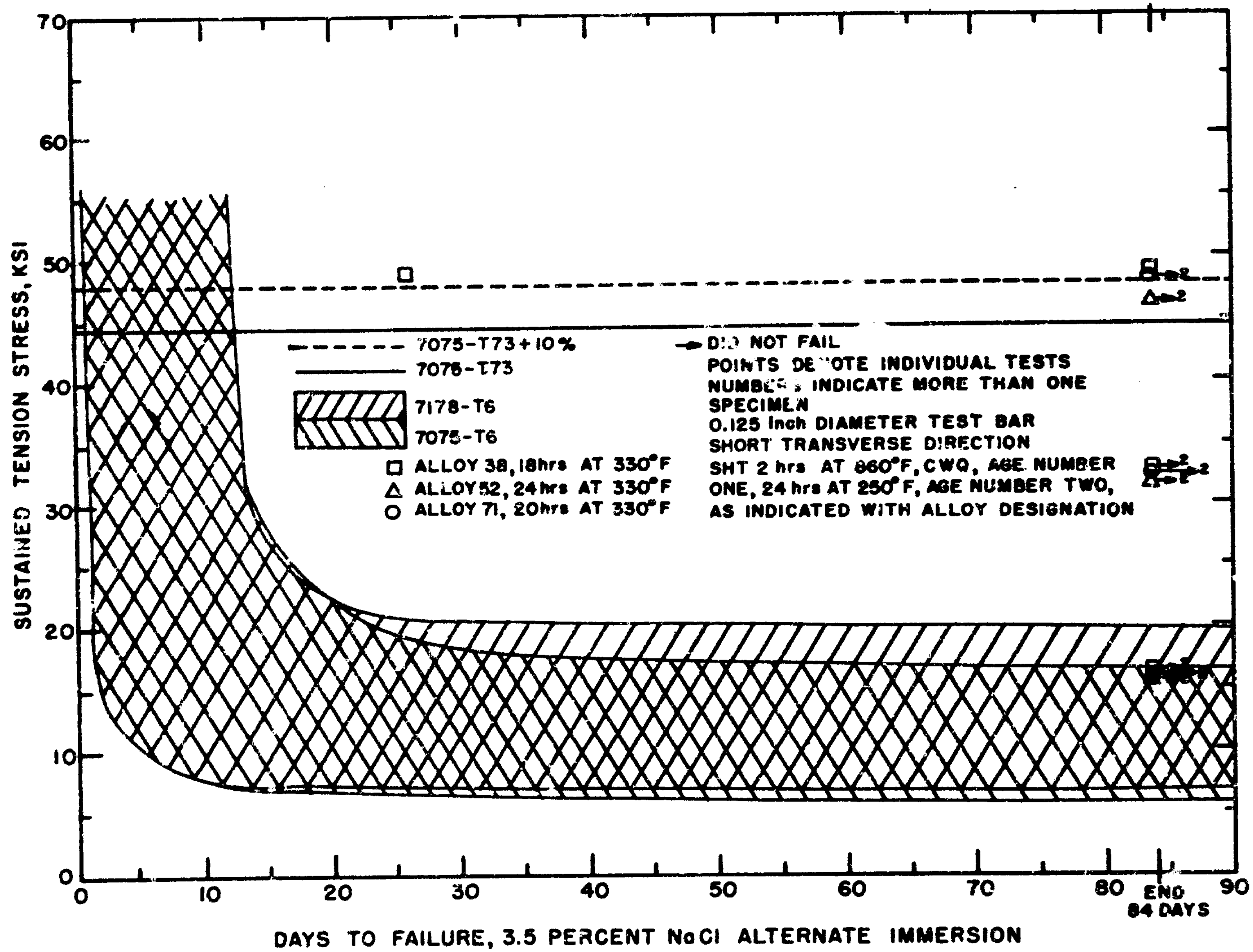


FIGURE 30

RELATIVE RESISTANCE OF APM ALLOYS 38, 52 AND 71 TO STRESS CORROSION CRACKING FOR TENSILE STRENGTHS OF APPROXIMATELY 10% GREATER THAN 7075-T7351

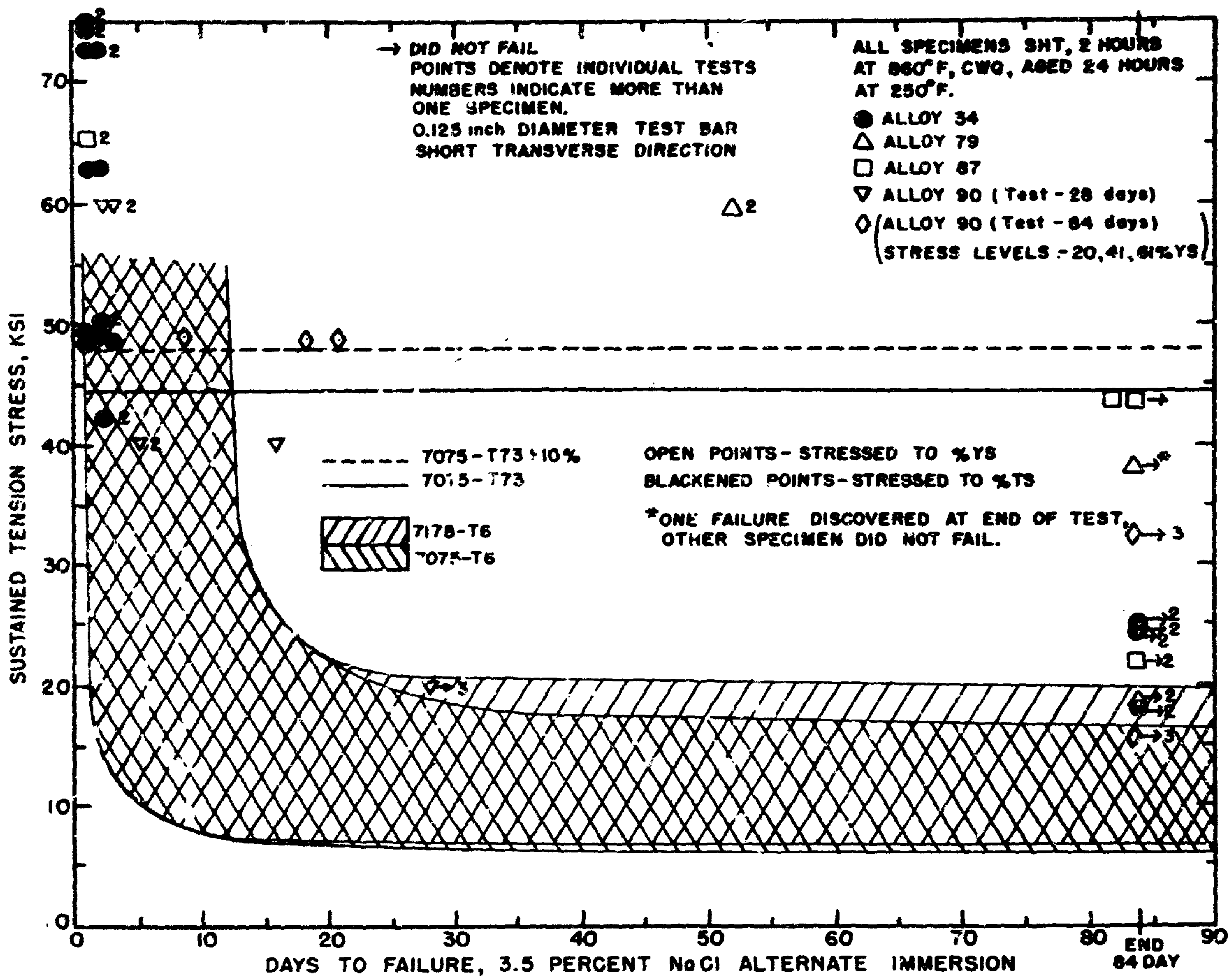


FIGURE 31
COMPARISON OF RELATIVE RESISTANCE TO STRESS CORROSION CRACKING OF APM ALLOY 34, 79, 87 AND 90 EXTRUSIONS

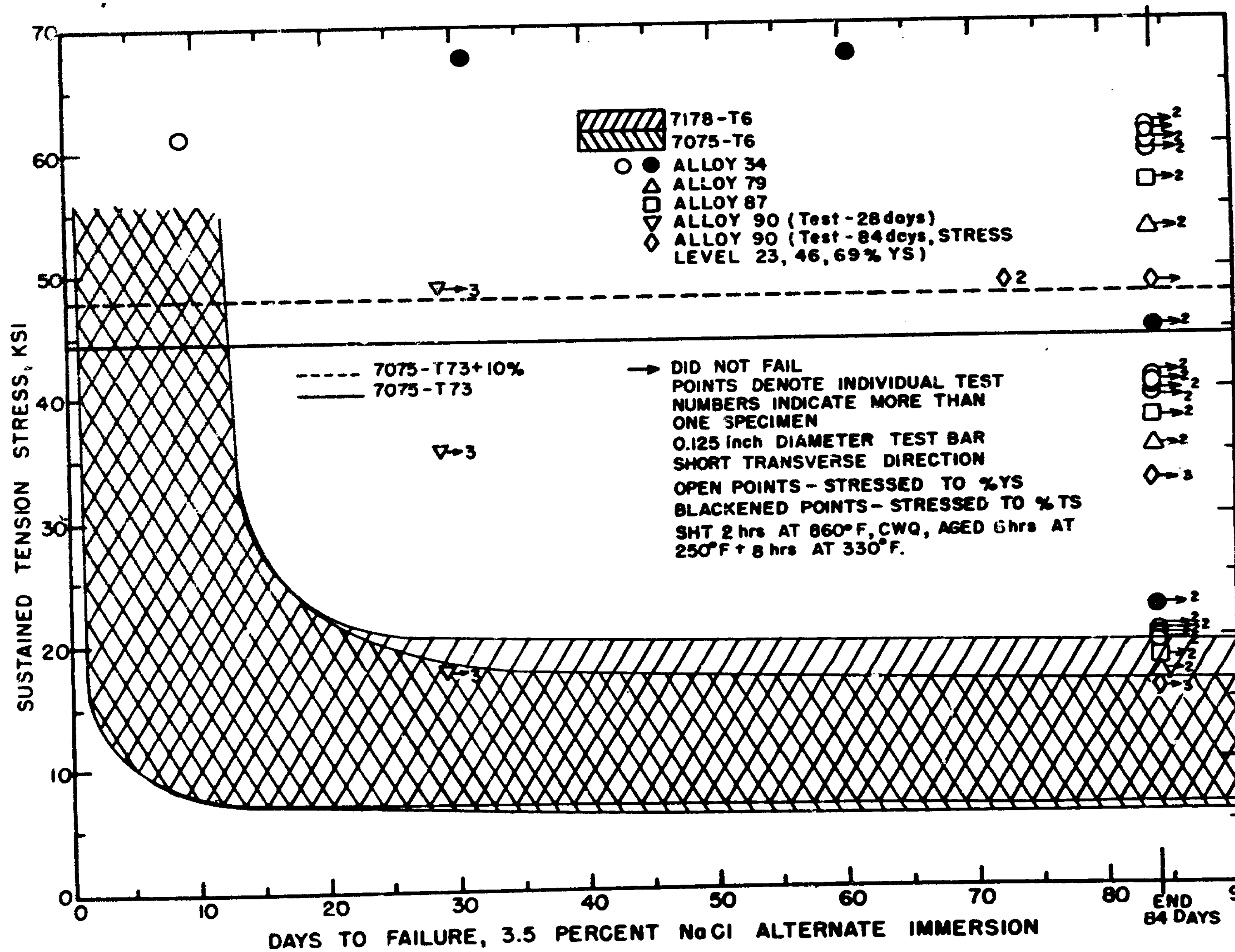


FIGURE 32

COMPARISON OF RELATIVE RESISTANCE TO STRESS CORROSION CRACKING OF APM ALLOY 34, 79, 87 AND 90 EXTRUSIONS

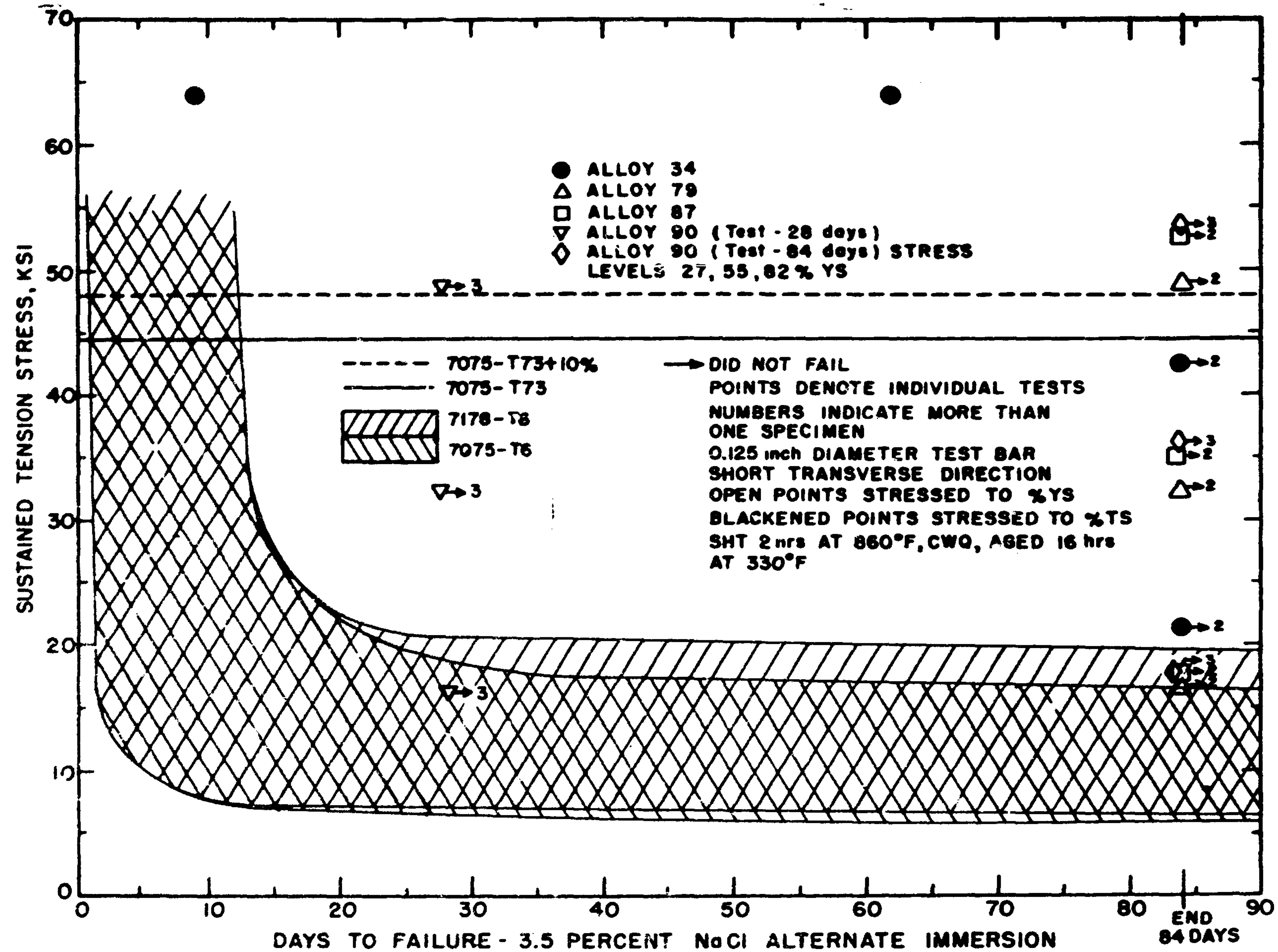


FIGURE 33

COMPARISON OF RELATIVE RESISTANCE TO STRESS CORROSION CRACKING OF APM ALLOY 34, 79, 87 AND 90 EXTRUSIONS

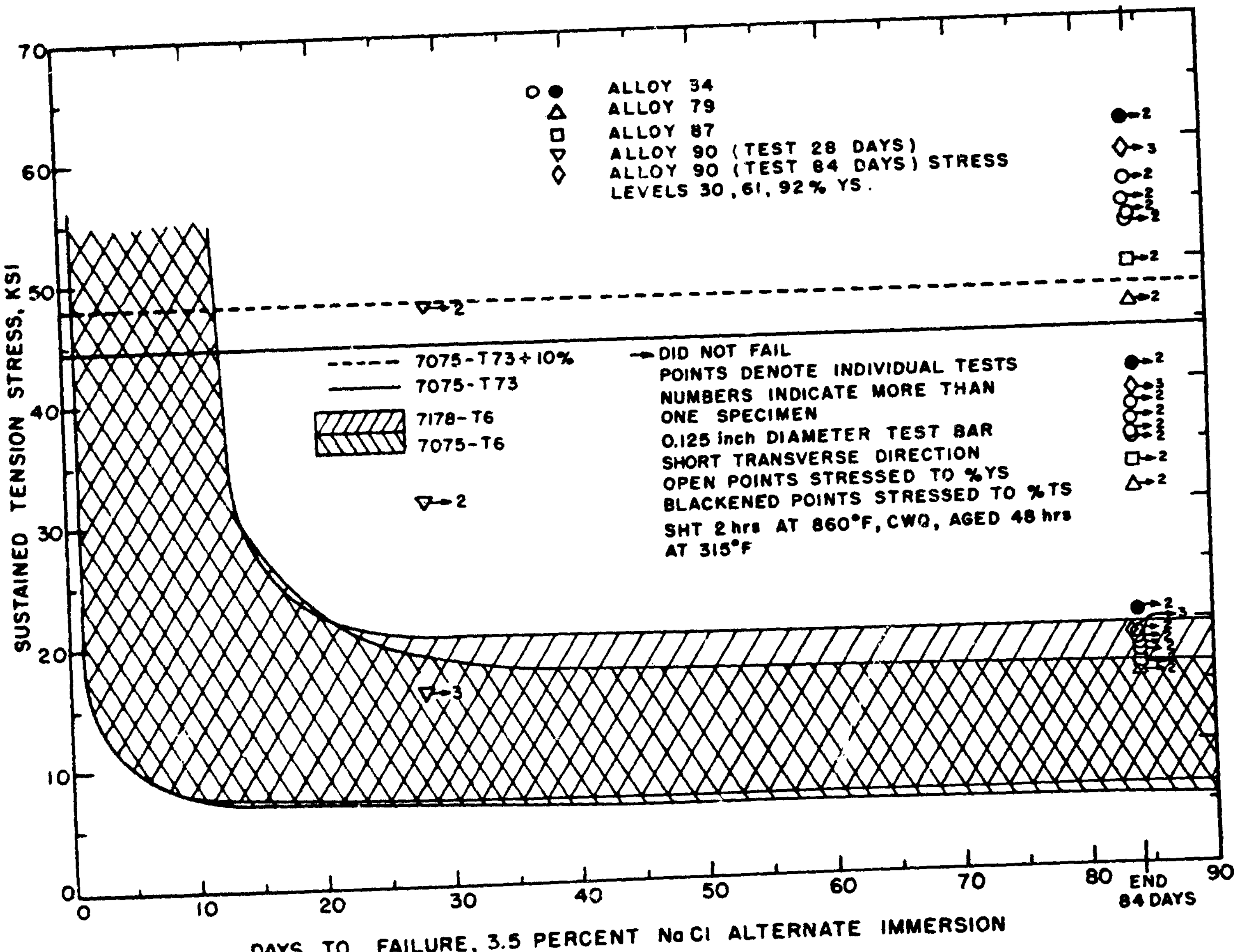
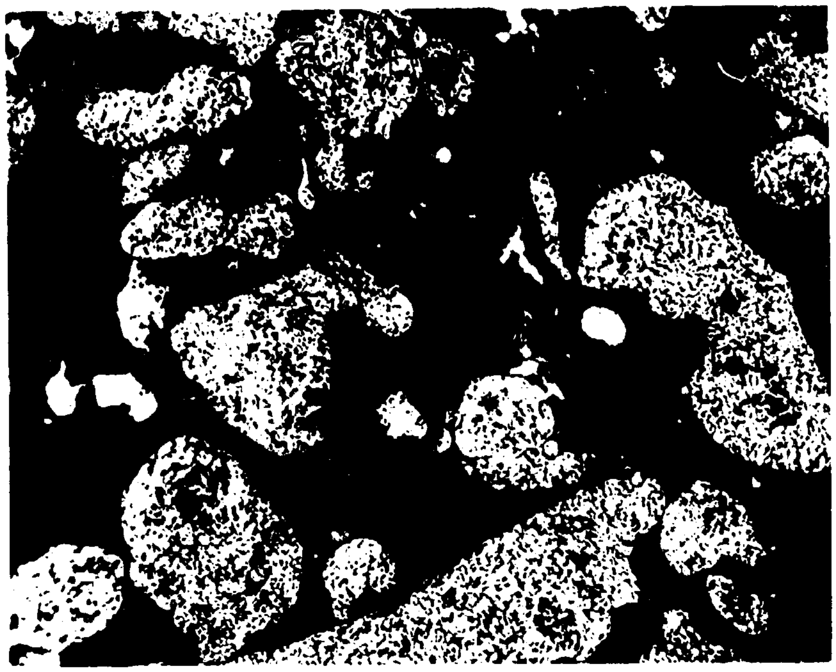
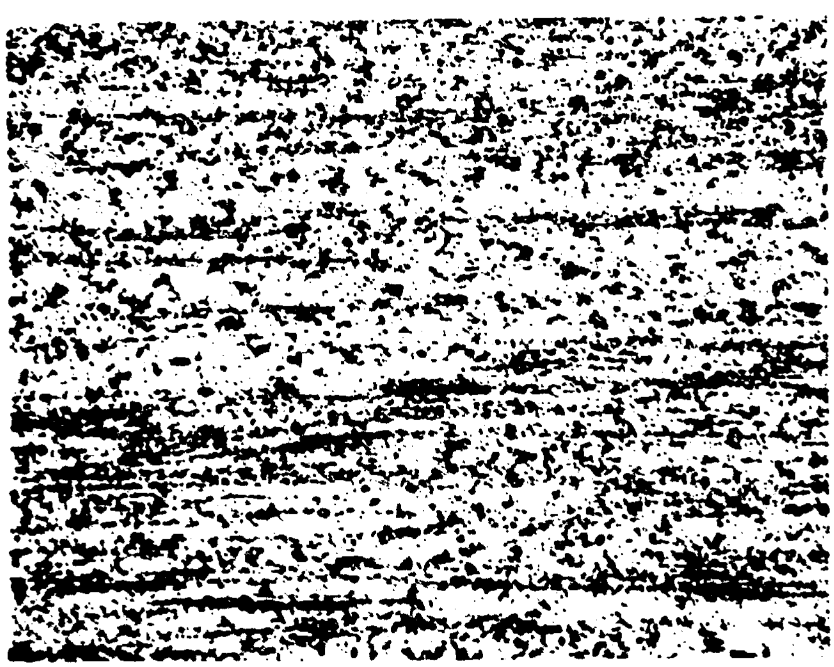


FIGURE 34

COMPARISON OF RELATIVE RESISTANCE TO STRESS CORROSION CRACKING OF APM ALLOY 34, 79, 87 AND 90 EXTRUSIONS

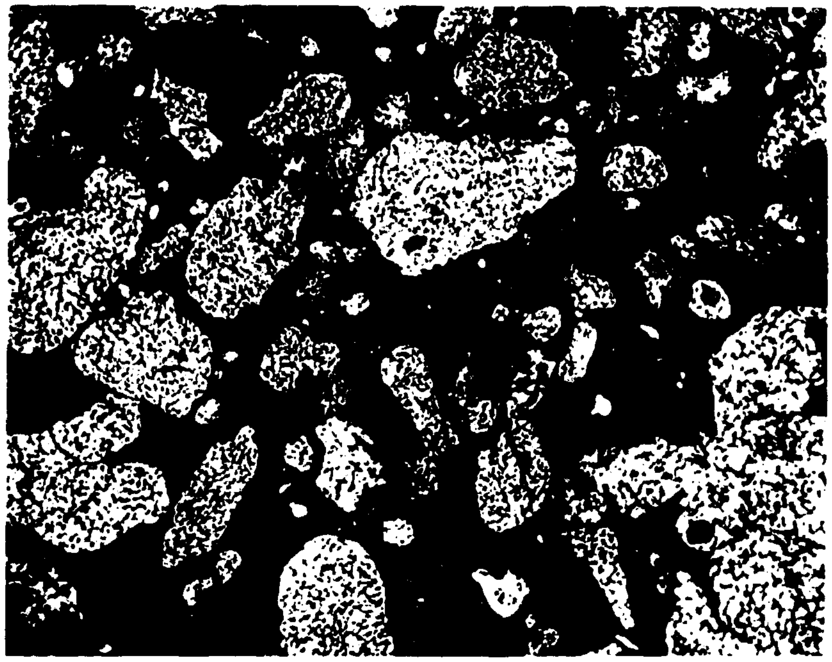


POWDER 500X
KELLER'S ETCH



EXTRUSION IN -T6 TEMPER 500X
KELLER'S ETCH LONG

FIGURE 35: ALLOY 38. Al-8.4 Zn - 3.6 Mg - 1.0 Mn - 0.8 Fe - 2.8 Ni

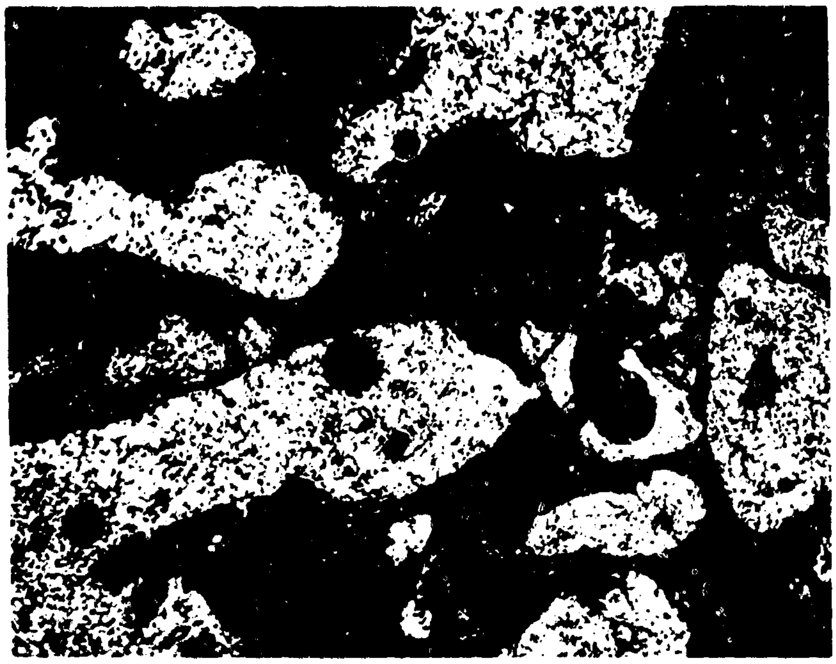


POWDER 500X
KELLER'S ETCH

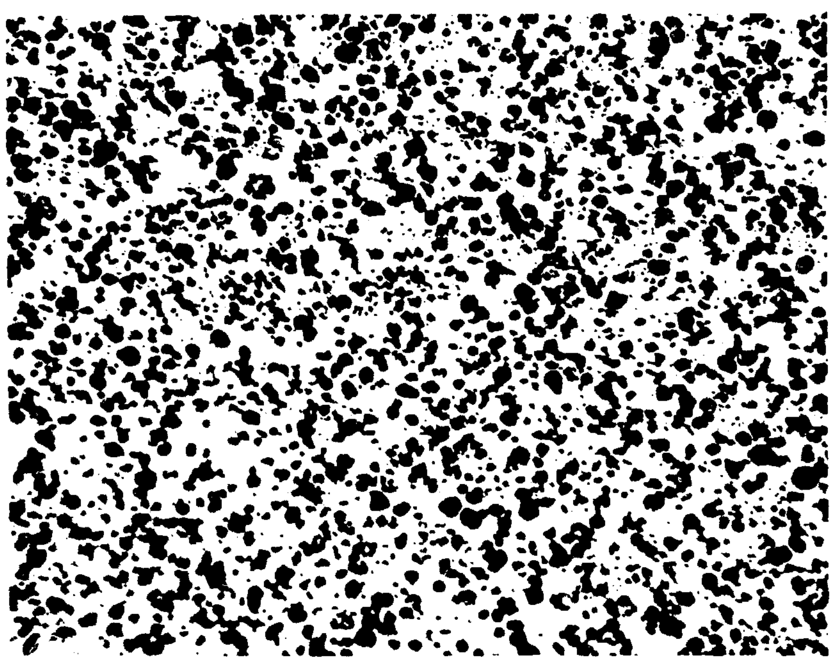
EXTRUSION IN -T6 TEMPER 500X
KELLER'S ETCH LONG

135281J
135282J

FIGURE 36: ALLOY 15. Al-11.4 Zn-3.4 Mg-1.5 Cu-.5 Cr-.5 Ti-.5 V-.6 Zr

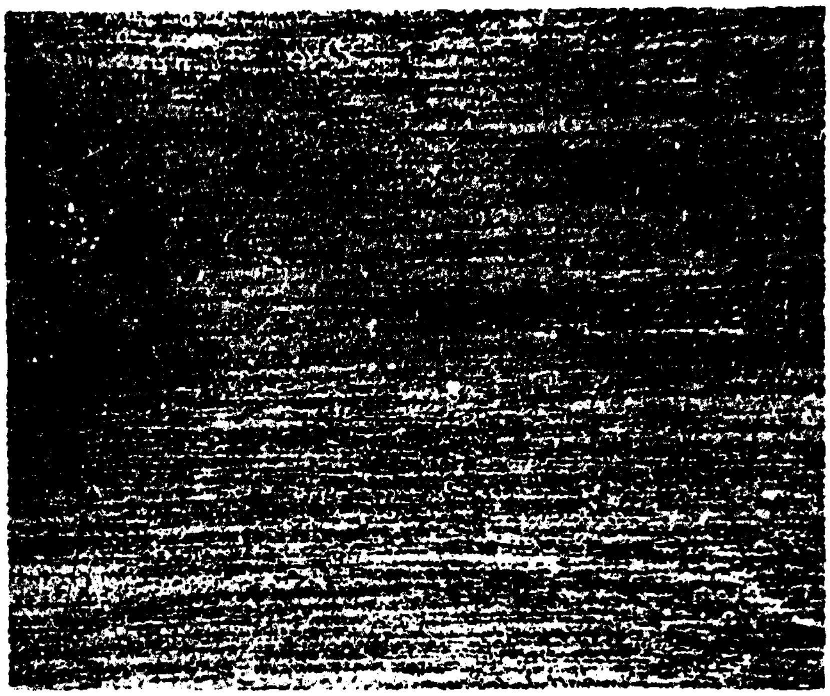


POWDER 500X
KELLER'S ETCH



EXTRUSION IN -T6 TEMPER 500X
KELLER'S ETCH LONG

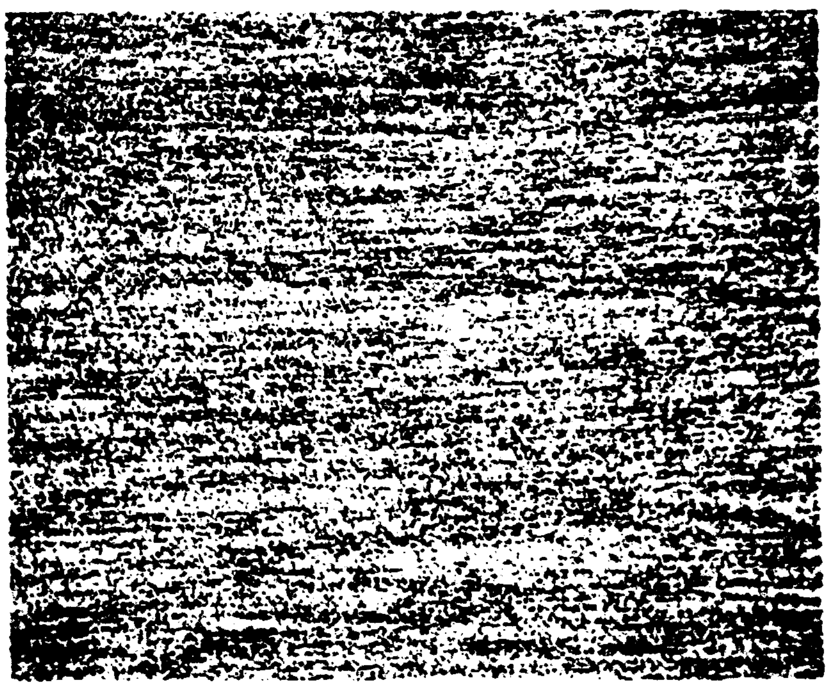
FIGURE 37: ALLOY 22. Al - 7.9 Zn - 8.4 Mg - 14.9 Cu



Extrusion in -T6 Temper 500X
Keller's Etch

Figure 38

Alloy 71. Al - 9.3 Zn - 3.6 Mg - 0.5 Cu - 0.7 Co.



Extrusion in -T6 + 20 hrs at 330°F Temper 500X
Keller's Etch

Figure 39

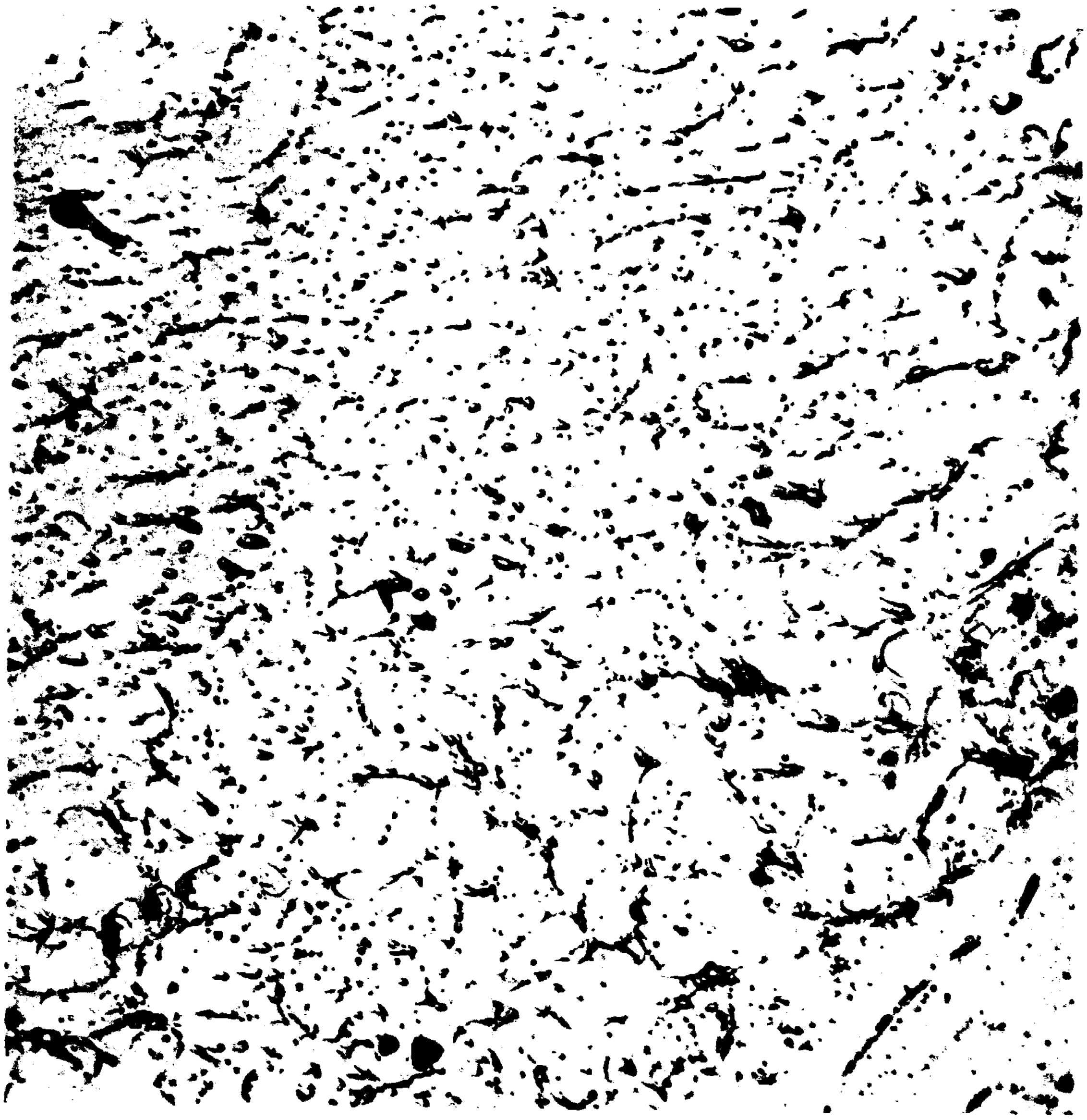
Alloy 71. Al - 9.3 Zn - 3.6 Mg - 0.5 Cu - 0.7 Co.

145181J
145182J

S-283269 Carbon Replica 20,000X

Figure 40

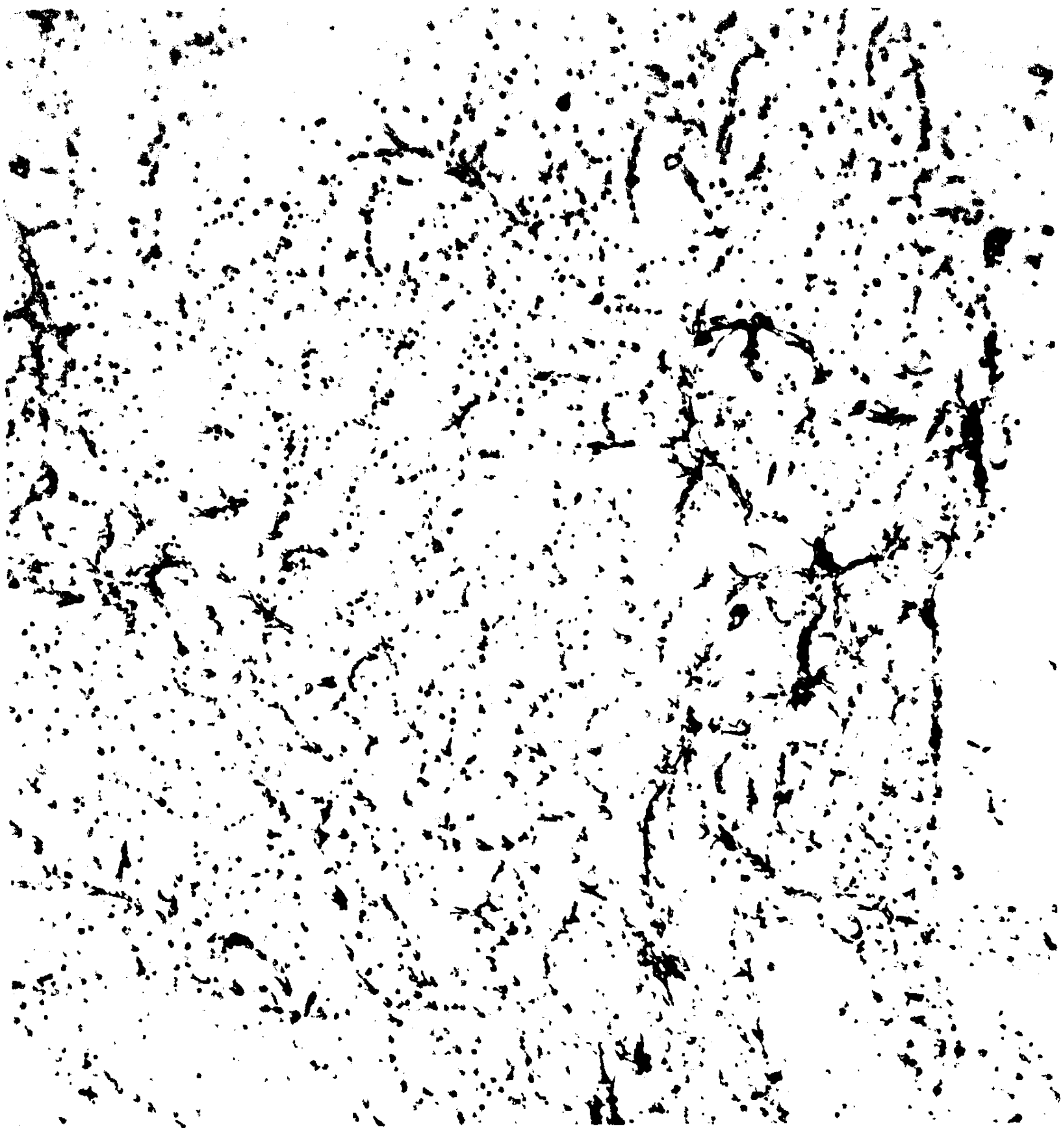
Electron micrograph showing the structure of Alloy 34 powder.



S-307598 Carbon Replica 20,000X

Figure 41

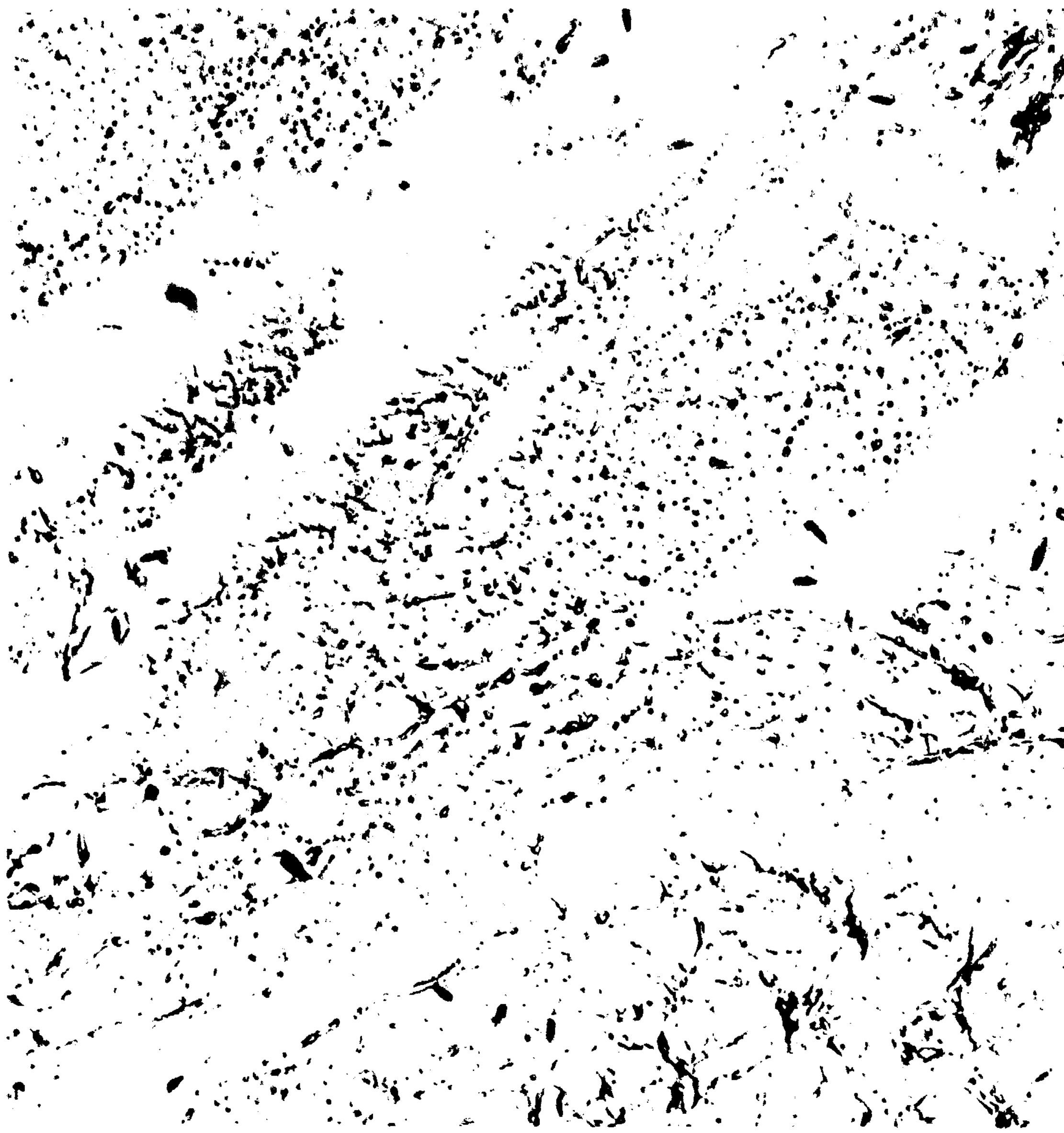
Electron micrograph showing the structure of Alloy 87 powder.



S-283274 Carbon Replica 20,000X

Figure 42

Electron micrograph showing the structure of Alloy 52 powder.



S-293303 Carbon Replica 20,000X

Electron micrograph showing the structure of Alloy 71 powder. Particles in this powder were slightly less uniformly dispersed than in the other powders.

Figure 43

S-283441-A Oxide Replica 10,000X

Alloy 34-T6 Powder Extrusion

Figure 44

Shows the structure (longitudinal section) of the extrusion made from Alloy 34 powder. Extrusion has been S.H.T. 2 hrs at 860°F, C.W.Q., Aged 24 hrs at 250°F.

S-283441-B Oxide Replica 10,000X

Alloy 34 Prolonged Age Powder Extrusion

Shows the structure (longitudinal section) of the extrusion made from Alloy 34 powder. Extrusion has been S.H.T. 2 hrs at 860°F, C.W.Q., Aged 48 hrs at 315°F.

Figure 45

S-293196-A Oxide Replica 10,000X

Alloy 87-T6 Powder Extrusion

Shows the structure (longitudinal section) of the extrusion formed from Alloy 87 powder. The extrusion had been S.H.T. 2 hrs at 860°F, C.W.Q. Aged 24 hrs at 250°F.

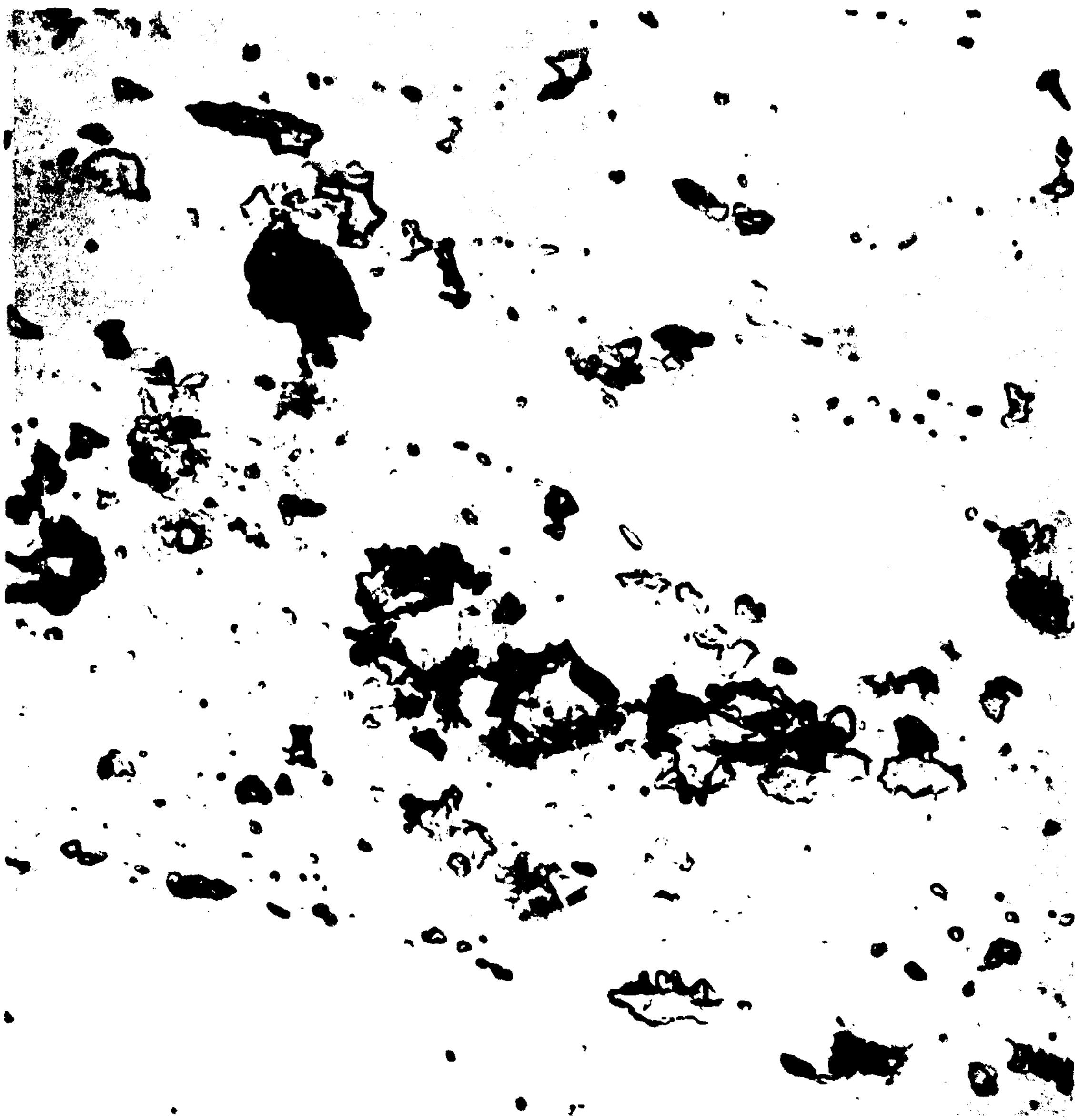
Figure 46

S-293196-B Oxide Replica 10,000X

Alloy 87 Prolonged Age Powder Extrusion

Figure 47

Shows the structure of Alloy 87 powder extrusion that had been S.H.T. 2 hrs at 860°F, C.W.Q. and Aged 48 hrs at 315°F. Probable identification of dispersoid and precipitate phases is noted.



S-283490-A Oxide Replica 10,000X

Alloy 52-T6 Powder Extrusion

Figure 48

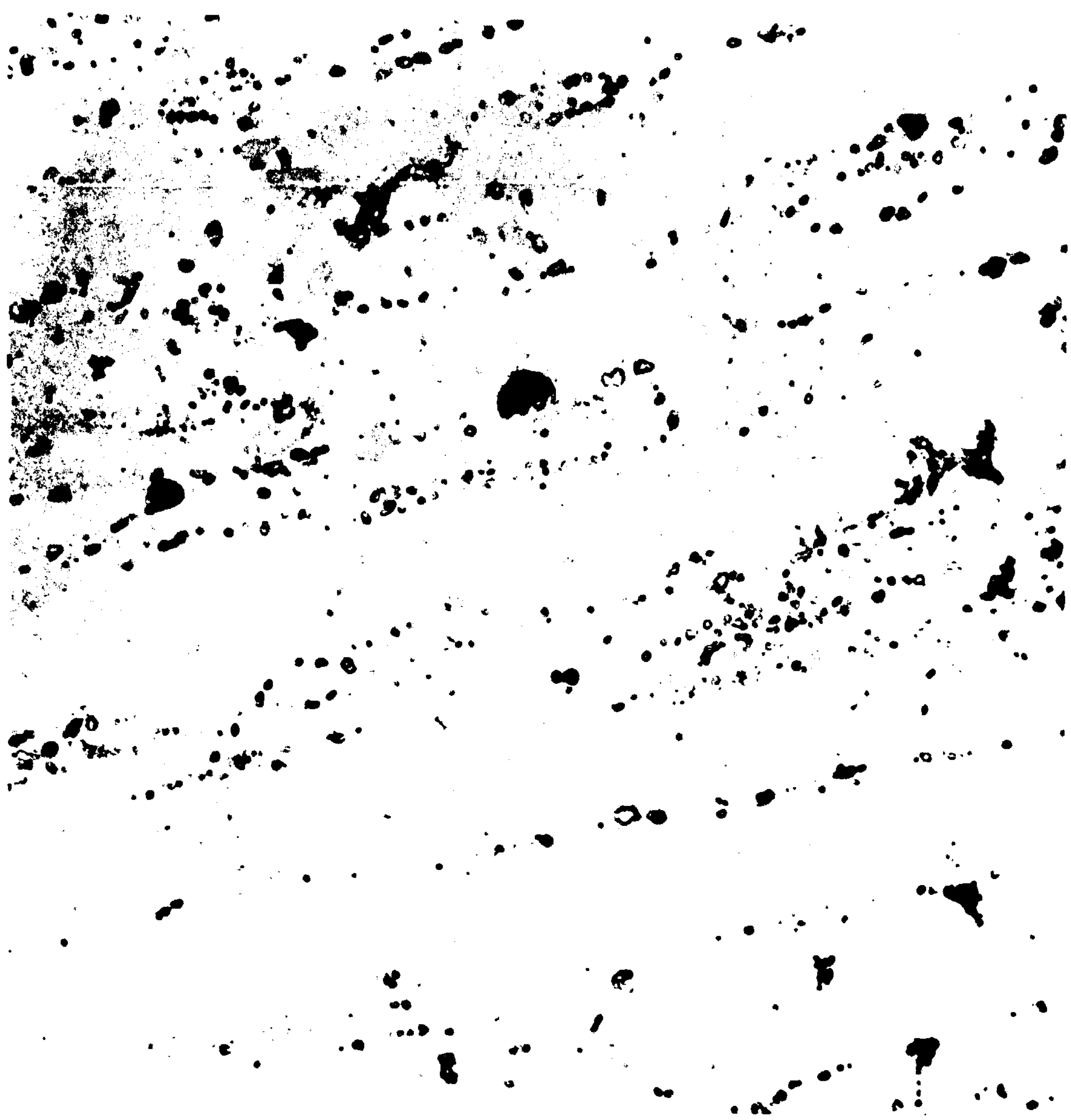
Shows the structure of the extruded section made from the Alloy 52 powder that was S.H.T. 2 hrs at 860°F, C.W.Q. and Aged 24 hrs at 250°F. Note the large amount of (Mg-Zn) precipitate relative to other sections of similar temper.

S-283490-C   Oxide Replica   10,000X

Alloy 52   Step Aged   Powder Extrusion

Figure 49

Shows the structure of Alloy 52 powder extrusion that had been step-aged 24 hrs at 250° + 20 hrs at 330°F after solution heat treatment.



S-293387-A Oxide Replica 10,000X

Alloy 71-T6 Powder Extrusion

Figure 50

Shows the structure (longitudinal section) of the extrusion made from Alloy 71 powder. The extrusion was S.H.T. 2 hrs at 860°F, C.W.Q. and Aged 24 hrs at 250°F.

S-293387-C Oxide Replica 10,000X

Alloy 71 Step Aged Powder Extrusion

Figure 51

Extrusion from Alloy 71 powder that had been step-aged 24 hrs at 250°F + 20 hrs at 330°F after S.H.T. Note increased amount of grain boundary precipitation.

APPENDIX A

Statistical Analyses of Alloy Compositions

Attempts at mathematically selecting compositions resulting in a certain strength have been conducted at times during the course of this contract. The initial evaluation was made on data compiled before the contract began. Two alloy groups were investigated, the Al-Zn-Mg-Cu-Mn-Cr and the Al-Zn-Mg-Cu-Fe-Ni-Mn-Cr series. Equations were obtained from the data and the predicted optimum tensile strength for each group was calculated. The predicted optimum tensile values, the resulting actual tensile values and the equations are listed in Appendix A, Table I. The predicted and actual values are not in close agreement, especially for the latter series. More data are required.

The statistical analyses of the initial 39 alloys resulted in the selection of the compositions of Alloys 43 through 59. These data were obtained using several applicable statistical tools. According to the evaluation, V, Zr, Co, Mo and W appear to have no significant effect on tensile strength. When these elements appeared, they were generally all present and the apparent lack of effect could have been an inability to extract information from the combined groups. The ranges worth investigating were Zn, 8 to 11%; Mg, 3 to 6%; Cu, 1 to 2.5%; Mn, 1 to 2%; Fe, 0 to 1.5%; Ni, 2 to 5%; Cr, 0 to 0.1%; and Ti, 0 to 0.1%. The analyses also indicated the "best" composition, which was atomized as Alloy 59. The results are listed below.

Alloy	Zn	Mg	Cu	Mn	Fe	Ni	Cr	Ti	Predicted T.S. ksi	Actual T.S., ksi H.T.#1	H.T.#2
--	10.0	4.0	1.5	1.5	1.0	4.0	0.0	0.0	123.0	--	--
59	10.2	3.9	1.6	1.6	1.0	4.1	-	-	--	99.3	83.9

The values are much lower than the predicted values; the reasons for this large difference are not known.

An evaluation of the Al-Zn-Mg-Cu-Mn and the Al-Zn-Mg-Cu-Mn-Fe-Ni alloys was made to determine if a higher strength alloy could be statistically selected. Alloys 1 to 3, 33, 35, 36, 39, 48 and 49 were used for the former group; these same alloys being given Heat Treatments #1 and #2 and evaluated by the optimum point equation. The resulting composition selected to give the highest predicted properties was compared to alloys with similar compositions and heat treatments along with actual properties and is given in Appendix A, Table II. The actual and predicted properties for compositions given Heat Treatment #1 were good. The composition required to give the optimum properties has already been studied. The multiple regression model was used to analyze all alloys having a yield strength of 90,000 psi or higher. The equation obtained is

$$\frac{\text{Y.S., ksi}}{10} = 5.932 + .5029\ Zn - .0215\ Zn^2 + .7205\ Mg - .0930\ Mg^2 - .0962\ Cu + .0046\ Cu^2 + .5335\ Mn - .1426\ Mn^2 - .1826\ Fe + .1622\ Fe^2 + .1031\ Ni - .0437\ Ni^2 - .4624\ Cr - .0639\ Ti - .1903\ (V+Zr+Mo+W) + .0485\ Co - .0015\ (Cr+Ti)^2 + .0082\ [Mg \times (Cu+Fe+Mn)] - .0154\ (Mg\times Mn) - .0010\ (Mg\times Zn) - .00008\ (Al\times Mg\times Cu) - .0011\ (Al\times Cu\times Fe)$$

Higher strengths were suggested if the Fe were raised, the Cu were eliminated or maintained at a low level and using Zn $\approx$ 11.7, Mg = 3.87, Mn = 1.87, and Ni = 1.18. All other alloying additions with the exception of perhaps Co are detrimental. A sample of the predicted yield strengths for several alloys follows:

Composition, %						Predicted
Zn	Mg	Cu	Mn	Fe	Ni	Yield, ksi
11.7	3.87	0.0	1.87	4.0	1.18	127.2
11.7	3.87	0.6	1.87	4.0	1.18	127.0
11.7	3.87	0.0	1.87	3.0	1.18	117.4
11.7	3.87	0.6	1.87	3.0	1.18	117.3

Between the initiation of this survey and the reporting of the results, the object of this contract was changed. This resulted in no alloys being made to obtain the high strengths predicted. Comparisons with existing data are not feasible since the Fe content is high and the ratio of 3 to 4 Fe to 1 Ni has not been investigated.

In conjunction with the revised objective, an optimum point program was conducted on Alloys 52 and 62 to 72. Each heat treatment, Nos. 1 through 3, was evaluated separately to give the highest elongation and the yield strength. The results are given in Appendix A, Table III. Also included are data for Alloy 71 which has a similar composition. The agreement between the predicted and actual yield strengths is quite good; the agreement between the elongations leaves much to be desired. Regression analysis was obtained also, the predicted elongation and yield strength for two alloys calculated from the equation. These results are given in Appendix A, Table IV. An alloy with a higher elongation is possible by lowering the Zn, Mg and Co and setting the Cu at

1.3%. Alloys 19 and 20 have a somewhat similar composition and were included for comparison. The elongation model predictions appear quite reasonable but the yield strength predictions may be high. In comparing the results of the optimum point program and the regression analysis, it is interesting to note that though the indicated alloys differ, the general conclusions of lower Zn and lower Co result from both approaches.

Selection of alloys by statistical methods as a means of obtaining desired properties is possible. The chances of obtaining a reliable value depend on the phases present in the samples and the logical selection of composition.

APPENDIX A

Table I

INITIAL STATISTICAL SELECTION OF COMPOSITION TO GIVE HIGH TENSILE PROPERTIES

Alloy	S. No.	Composition, % Zn	Mg	Cu	Mn	Cr	Fe	Ni	Tensile Strength, ksi Actual Avg.	Predicted	Equation
--		9.2	3.4	1.2	1.1	0.0	--	--	--	117.5	1
33	277405	9.0	3.5	1.2	1.1	--	--	--	108.0	--	
--		6.5	2.7	0.6	0.0	0.1	0.0	2.0	--	116.2	2
32	277404	6.6	2.7	0.6	--	0.1	--	2.3	97.0	--	

Equation (1)

$$TS = \frac{117.5}{1 + (.075\ Zn-.685)^2 + (.218\ Mg-.750)^2 + (.370\ Cu-.434)^2 + (.321\ Mn-.354)^2 + (.416\ Cr-.078)^2}$$

Equation (2)

$$TS = \frac{116.2}{1 + (.083\ Zn-.537)^2 + (.052\ Mn-.141)^2 + (.169\ Cu-.103)^2 + (.027\ Ni-.053)^2 + (.029\ Mn)^2 + (1.42\ Cr-.144)^2}$$

APPENDIX A

Table II

SUMMARY OF HIGH STRENGTH STATISTICAL ANALYSES PROGRAMS (a)

Alloy	Composition, %								H.T. No.	Avg. Tensile Properties, ksi			
										Actual		Predicted	
	Zn	Mg	Cu	Mn	Fe	Ni	Cr	Ti		T.S.	Y.S.	T.S.	Y.S.
36(b)	10.7	3.8	2.0	1.7	--	--	--	--	1	--	106.0	--	105.3
--	10.88	4.9	2.0	1.71	--	--	--	--	1	--	--	108.3	--
39	10.9	4.9	2.0	1.7	--	--	--	--	1	110.0	--	--	--
--	8.4	3.6	0.006	0.99	0.80	2.81	0.0	0.0002	2	--	--	109.6	--
38	8.4	3.6	0.0	1.00	0.80	2.80	0.0	0.00	2	119.6	--	--	--

(a) Optimum point analysis.

(b) Predicted alloy had same composition as Alloy 36.

APPENDIX A

Table III

SUMMARY OF RESULTS ON OPTIMUM POINT PROGRAMS OF HIGH ELONGATION ALLOYS

Heat Treatment	Composition, % Zn	Mg	Cu	Co	Yield Strength, ksi Predicted	Actual Avg.(b)	Elongation, % Predicted	Actual Avg.(b)
1	9.43	NE(3.6-4.7)(a)	0.72	0.85	103.2	105.0	2.57	3.1
2	9.29	NE(3.6-4.7)	NE(0.6-1.5)	0.88	112.1	112.0	2.13	3.7
3	9.37	4.10	0.55	0.7	109.8	111.4	1.80	2.4
(b)	9.2	3.6	0.6	0.8	--	--	--	-

(a) NE = Negligible effect in range studied.

(b) Alloy 71 has a similar composition and actual properties to the predicted optimums.

H.T.#1

$$YS = \frac{104.03}{1 + (.0017)(Zn-11.10)^2 + (.0438)(Cu-1.008)^2}$$

$$EL = \frac{2.568}{1 + (.0209)(Zn-9.43)^2 + (.1186)(Cu-.725)^2}$$

H.T.#2

$$YS = \frac{112.09}{1 + (.0021)(Cu-1.31)^2}$$

$$EL = \frac{2.133}{1 + (.2827)(Zn-9.29)^2 + (.9181)(Co-.88)^2}$$

H.T.#3

$$YS = \frac{109.79}{1 + (.0074)(Mg-4.1)^2 + (.0389)(Cu-.60)^2}$$

$$EL = \frac{1.803}{1 + (.1564)(Zn-9.37)^2 + (.0369)(Cu-.551)^2 + (.4999)(Co-.737)^2}$$

APPENDIX A

Table IV

SUMMARY OF RESULTS OF REGRESSION ANALYSES ON HEAT TREATMENT #1 HIGH ELONGATION ALLOYS

Alloy	Composition, %				Yield Strength, ksi		Elongation, %	
	Zn	Mg	Cu	Co	Predicted	Actual Avg.	Predicted	Actual Avg.
--	8.0	3.0	1.3	0.5	107.7	--	6.6	--
--	9.0	3.0	1.3	0.5	107.1	--	5.8	--
19	7.5	3.0	1.7	0.0	--	95.3	--	7.2
20	7.8	3.6	2.3	0.0	--	94.8	--	4.0

$$YS = 284.91 - 20.53\ Zn - 39.30\ Mg - 17.37\ Cu + .17\ Co + 1.17\ Zn^2 + 4.61\ Mg^2 + 6.52\ Cu^2 - .28\ Co^2$$

$$EL = 60.70 - 4.89\ Zn - 15.81\ Mg + 1.13\ Cu - 2.06\ Co + .24\ Zn^2 + 1.92\ Mg^2 + .42\ Cu^2 + .30\ Co^2$$

APPENDIX B

Hardness Value

The heat treated APM alloys have hardnesses much higher than usually associated with aluminum, Table I. During the step aging evaluation, a possible correlation between the strength and hardness was sought. A number of alloys were given Heat Treatment #1 with Age #2 at 330°F or 350°F, the hardness values being taken at predetermined intervals, Tables II and III. The results of these and also earlier tests were evaluated graphically. The poor reproducibility of several lots of Alloy 52 is seen in Figure 1. The excellent strength reproducibility is contrasted to the poor hardness reproducibility in the main text in Figure 9, also for Alloy 52. Work was discontinued.

Appendix B

Table I

HARDNESS VALUES OF SELECTED APM ALLOYS

Alloy Number	Sample Number	H.T. No. (a)	Test Piece (b)	Rockwell Hardness	Brinell Hardness (c)
34	283442	2	A	G-79	(189)
	283449	2	B	----	230 (e)
	283449	3	B	----	229 (e)
38	283454	2	A	G-80	(192)
	283459	2	B	----	208 (e)
	283459	3	B	----	210 (e)
39	283463	1	A	G-71	(167)
	283467	2	A	G-80	(192)
49	283471	2	A	G-84	(210)
	283472	2	A	G-79	(189)
50	284130	F	C	B-56	(90)
	284130	2	C	G-86	(220)
	283484	2	A	G-84	(210)
52	307454	1	E	----	190 (e)
	307454	1	F	----	189 (e)
	307455	1	E	----	188 (e)
	307455	1	F	----	186 (e)
	307454	2	E	----	195 (e)
	307454	2	F	----	204 (e)
	307455	2	E	----	182 (e)
	307455	2	F	----	190 (e)
	283497	2	A	G-73	(172)
	284131	2	D	G-87	226 (d)
	284131	2	D	----	213 (e)
	284131	3	D	G-84	204 (e)
	284131	3	D	----	219 (f)
62	307321	1	E	----	186 (e)
	307321	1	F	----	181 (e)
	307321	2	E	----	190 (e)
	307321	2	F	----	188 (e)
64	307323	1	E	----	176 (e)
	307323	1	F	----	186 (e)
	307323	2	E	----	176 (e)
	307323	2	F	----	192 (e)
71	307330	1	E	----	191 (e)
	307330	1	F	----	192 (e)
	307330	2	E	----	185 (e)
	307330	2	F	----	190 (e)

(a) Heat Treatment
- F - As Fabricated.
- #1 - SHT 2 hrs. at 860°F, CWQ, Aged 24 hrs. at 250°F.
- #2 - SHT 1/2 hr. at 920°F, CWQ, Aged 96 hrs. at 225°F.
- #3 - SHT 2 hrs. at 860°F, CWQ, Aged 96 hrs. at 225°F.

(b) Test Pieces
- A - Broken tensile specimens from 2 in. dia. extruded rod.
- B - Rolled plate from hot press forged compacts.
- C - Slices from hot compacted billets.
- D - Section of rolled plate from 1" x 4-1/4" extrusion 1/2" thick.
- E - Section of rolled sheet from 1" x 4-1/4" extrusion 1/10" thick.
- F - Section of rolled plate from 1" x 4-1/4" extrusion 1/4" thick.

(c) Values in parenthesis are converted from Rockwell to Brinell Hardness values using a 500 kg load and a 10 mm ball. Source: ASM Metals Handbook, 1948 Edition, p. 101

(d) 1500 kg load and 10 mm ball.

(e) 500 kg load and 10 mm ball.

(f) 3000 kg load and 10 mm ball.

APPENDIX B

Table II

ROCKWELL G HARDNESS VALUES OF SELECTED ALLOYS AFTER PROLONGED AGING AT 330°F

Alloy/S. No.

Additional Aging Time(a) at 330°F, Hours	5 277377 C	5 277377 M	7 277379 C	7 277379 M	8 277380 C	8 277380 M	14 277386 C	14 277386 M	33 277405 C	33 277405 M	38 283452 C	38 283452 M
2	G75	G77	G75	G78	G79	G79	G80	G81	G75	G76	G79	G79
4	73	73	76	76	78	78	77	78	73	73	75	76
6	71	71	74	74	75	76	75	76	71	71	72	74
8	68	69	72	73	74	75	73	73	69	69	70	72
10	66	67	70	71	72	73	71	72	67	67	69	69
12	65	65	69	70	71	72	69	70	65	65	67	68
14	62	64	68	70	70	70	68	70	63	64	66	66
16	62	63	67	69	70	70	67	69	63	64	66	66
18	61	63	67	69	70	70	66	69	63	64	66	66
22	61	62	66	68	69	70	66	68	62	63	64	64
26	60	60	65	67	68	68	65	65	60	61	63	63
30	57	59	65	65	67	67	64	64	59	60	61	62
34	56	58	63	65	65	66	63	63	57	59	61	62
38	54	56	62	64	64	66	62	62	56	57	60	61
42	53	54	61	63	64	65	61	61	55	57	59	61
46	53	54	61	63	64	65	61	62	55	57	59	61
50	53	54	61	62	64	64	61	62	54	56	58	60

Additional Aging Time(a) at 330°F, Hours	39 283464 C	39 283464 M	40 277428 C	40 277428 M	49 283470 C	49 283470 M	50 283482 C	50 283482 M	51 278249 C	51 278249 M	52 283492 C	52 283492 M	54 278252 C	54 278252 M	57 278255 C	57 278255 M	66 307314 C	66 307314 M
2	G79	G80	G78	G78	G78	G80	G77	G79	G81	G81	G76	G77	G81	G82	G83	G83	G77	G77
4	79	78	75	76	76	77	76	77	77	78	74	73	80	80	80	71	73	74
6	77	76	74	75	74	74	74	75	75	77	70	71	78	80	79	80	71	72
8	74	75	73	72	71	72	72	73	75	74	69	70	76	77	77	78	69	70
10	73	74	72	72	70	70	70	71	71	73	66	67	75	76	76	76	67	68
12	72	73	70	70	68	69	69	70	69	71	65	65	74	74	75	75	65	66
14	71	71	70	69	66	67	68	69	68	70	62	64	73	73	73	74	63	64
16	70	71	70	69	66	67	68	69	68	69	63	64	73	73	73	74	63	64
18	70	71	69	69	66	67	68	69	68	69	63	64	73	73	73	74	63	64
22	69	69	69	69	64	65	65	67	68	68	61	62	72	72	72	73	62	63
26	67	67	68	68	63	64	64	65	67	67	60	61	71	71	70	71	59	60
30	67	67	67	67	62	64	63	64	66	66	58	59	69	70	70	70	59	59
34	65	66	66	67	61	63	63	64	64	65	57	58	68	69	69	69	57	58
38	64	65	65	66	60	61	62	63	64	65	55	57	66	68	68	69	56	57
42	64	65	65	66	60	61	61	62	63	65	56	57	67	68	68	69	56	57
46	64	64	65	65	60	61	61	60	63	64	56	57	67	68	68	69	56	56
50	64	64	65	65	60	62	61	60	62	63	56	57	66	67	67	68	56	56

NOTE: (a) S.H.T. 2 hrs. at 860°F, C.W.Q., Age #1 - 24 hrs. at 250°F

C - Center
M - Midway

APPENDIX B

Table III

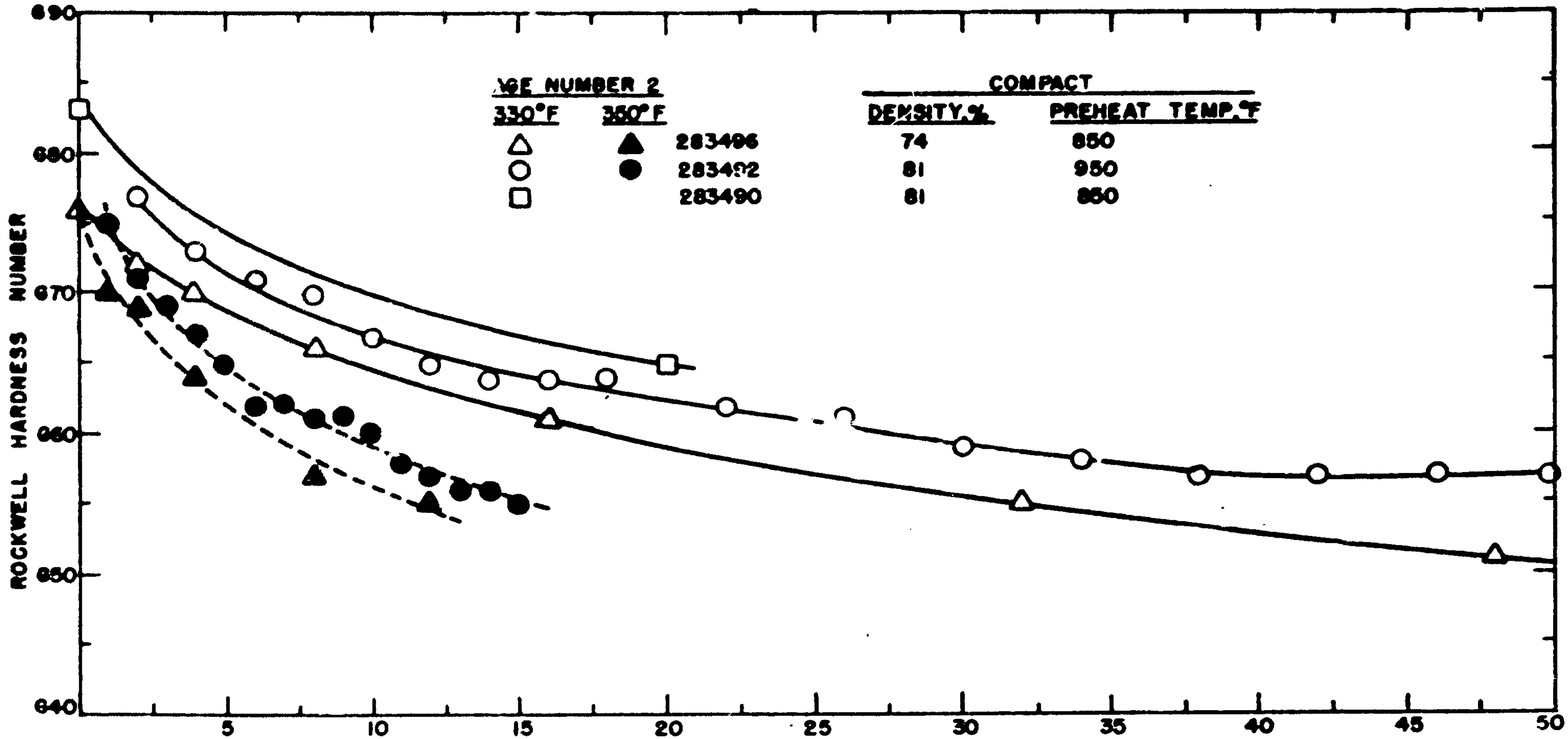
ROCKWELL G HARDNESS VALUES OF SELECTED ALLOYS AFTER PROLONGED AGING AT 350°F

Additional Aging Time at 350°F, Hours (a)	Alloy/S. No. 5 277377 C	5 277377 M	7 277379 C	7 277379 M	8 277380 C	8 277380 M	14 277386 C	14 277386 M	33 277405 C	33 277405 M	38 283452 C	38 283452 M	39 283464 C	39 283464 M
1	G74	G75	G77	G77	G78	G79	G77	G79	G74	G73	G73	G77	G79	G80
2	70	71	74	75	76	76	74	75	70	70	72	73	76	77
3	69	70	72	73	73	74	72	73	68	69	71	71	75	75
4	66	67	70	70	71	72	69	71	66	67	68	69	72	72
5	64	66	69	69	70	71	69	69	64	66	65	67	71	72
6	63	63	67	68	69	69	67	68	62	63	63	65	70	71
7	61	63	66	68	69	68	66	67	61	62	63	65	69	69
8	59	60	66	67	68	68	64	65	59	61	63	64	67	68
9	59	60	65	66	68	68	64	65	58	59	63	64	67	68
10	58	60	64	66	66	66	63	64	57	58	62	63	66	67
11	58	59	64	65	65	65	62	63	56	58	61	61	65	66
12	56	58	63	64	65	65	62	63	56	58	60	60	65	65
13	55	57	63	63	64	63	62	63	56	58	60	60	64	64
14	54	57	63	62	63	63	60	61	54	57	59	60	64	64
15	54	57	63	62	63	64	60	61	54	56	59	59	62	64

Additional Aging Time at 350°F, Hours (a)	40 277428 C	40 277428 M	49 283470 C	49 283470 M	50 283482 C	50 283482 M	51 278249 C	51 278249 M	52 283492 C	52 283492 M	54 278252 C	54 278252 M	57 278255 C	57 278255 M	66 307314 C	66 307314 M
1	G77	G77	G78	G77	G78	G78	G79	G79	G74	G75	G80	G81	G81	G82	G75	G75
2	74	75	74	75	75	75	76	76	71	71	78	78	79	80	71	71
3	71	70	72	72	73	73	73	74	69	69	76	76	77	77	68	68
4	69	70	69	70	70	70	70	71	66	67	74	75	74	75	65	66
5	69	70	66	68	69	69	70	71	64	65	73	73	74	75	64	65
6	69	69	66	67	68	68	68	69	62	62	71	72	72	73	63	64
7	68	69	65	66	67	68	67	68	61	62	71	72	70	72	62	63
8	67	68	64	65	66	66	65	67	60	61	69	70	70	72	59	60
9	67	68	63	64	65	66	65	67	60	61	69	70	70	72	59	60
10	67	68	62	63	64	65	64	67	59	60	68	69	70	71	58	59
11	67	67	61	62	63	64	64	66	57	58	68	69	69	70	57	59
12	67	67	61	62	63	64	64	64	56	57	66	68	68	70	55	57
13	66	67	60	61	62	63	64	64	56	56	66	68	68	69	55	57
14	65	66	60	61	62	63	62	63	55	56	66	67	68	69	54	56
15	64	66	59	60	61	62	61	63	55	55	66	67	68	69	54	56

NOTE: (a) S.H.T. 2 hrs. at 860°F, C.W.Q., Age #1 - 24 hrs. at 250°F

C - Center
M - Midway



AGE NUMBER 2, TIME AT TEMPERATURE – HOURS
(ALL SPECIMENS SHT 2 HOURS AT 860°F, CWQ, AGED NUMBER 1, 24 HOURS AT 250°F)
(HARDNESS READING TAKEN MIDWAY BETWEEN SURFACE AND CENTER)

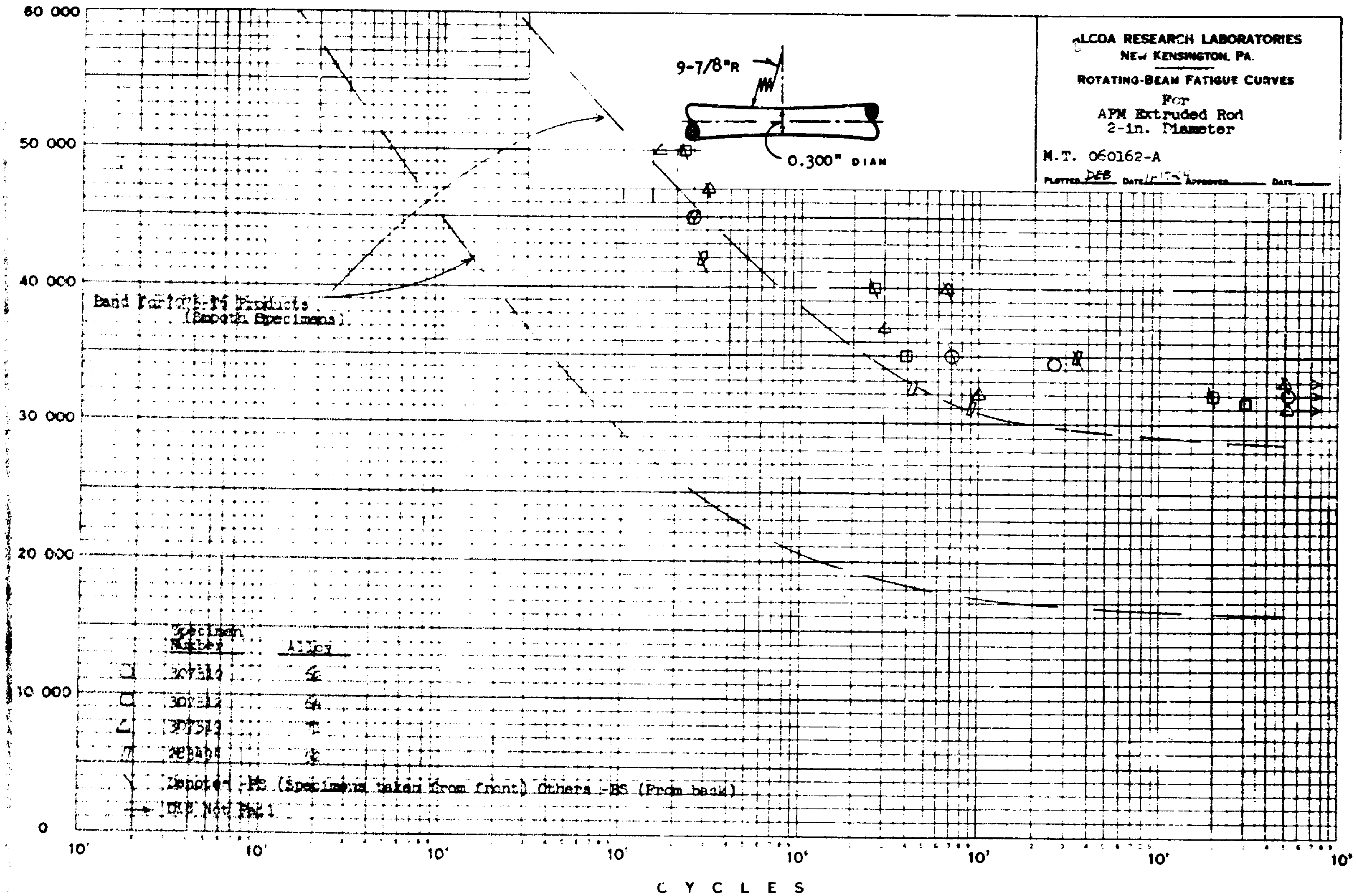
APPENDIX B
FIGURE 1

THE EFFECT OF PROLONGED AGING ON HARDNESS OF ALLOY 52

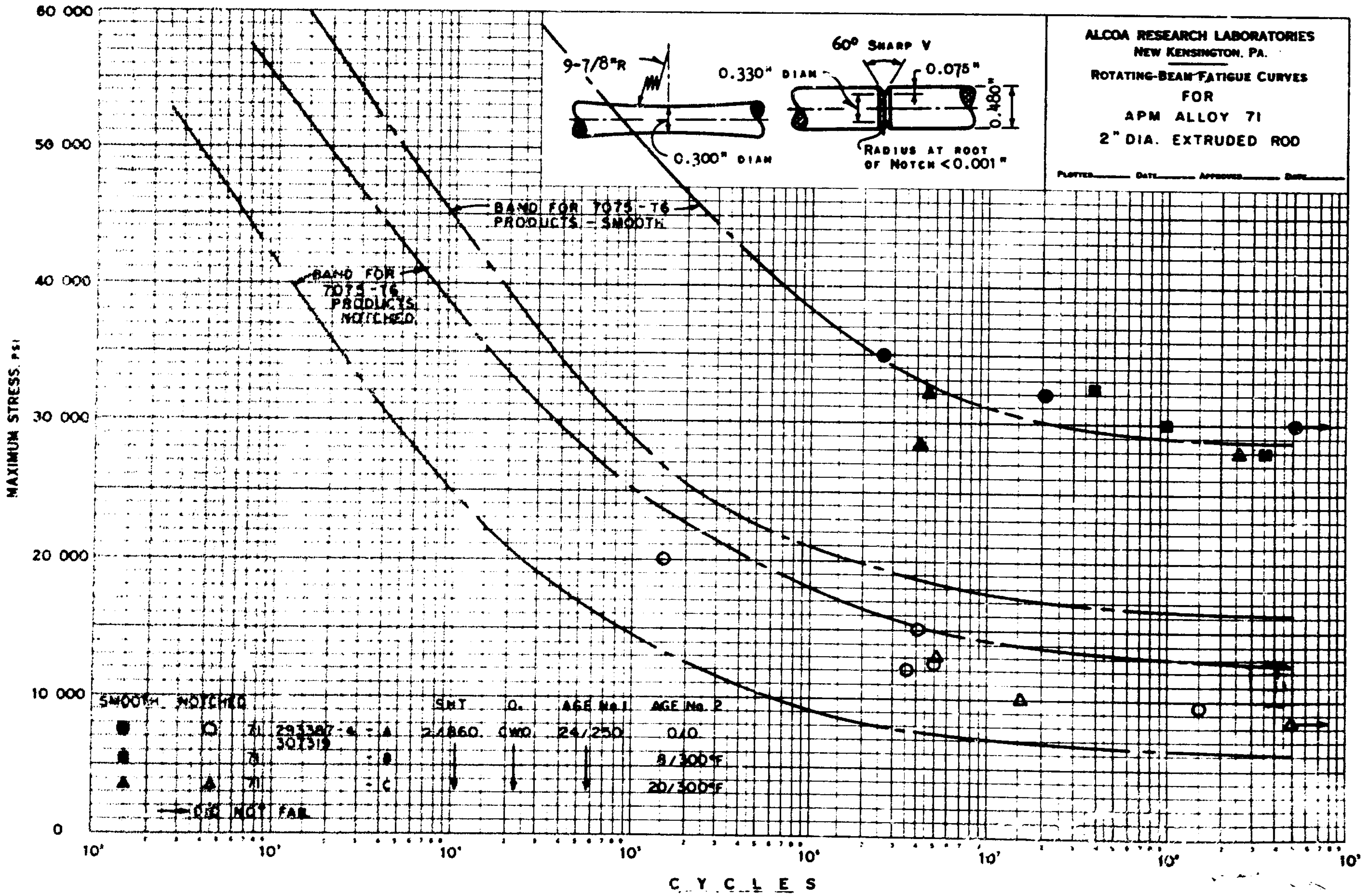
APPENDIX C

Fatigue limits were determined on smooth (unnotched) specimens machined from extruded stock of Alloys 52, 62, 64 and 71. The specimens were given Heat Treatment #1. The results are compared with the 7075-T6 product scatter band, Figure 1. The fatigue limits of these alloys generally fall above the 7075-T6 band with a few falling on or just below the upper limit of the band. The fatigue limit for Alloy 62 is approximately 32 ksi, for Alloy 64 approximately 31 ksi, and for Alloy 71 approximately 32 $\pm$ 1 ksi. No fatigue limit was determined for Alloy 52 because of testing difficulties.

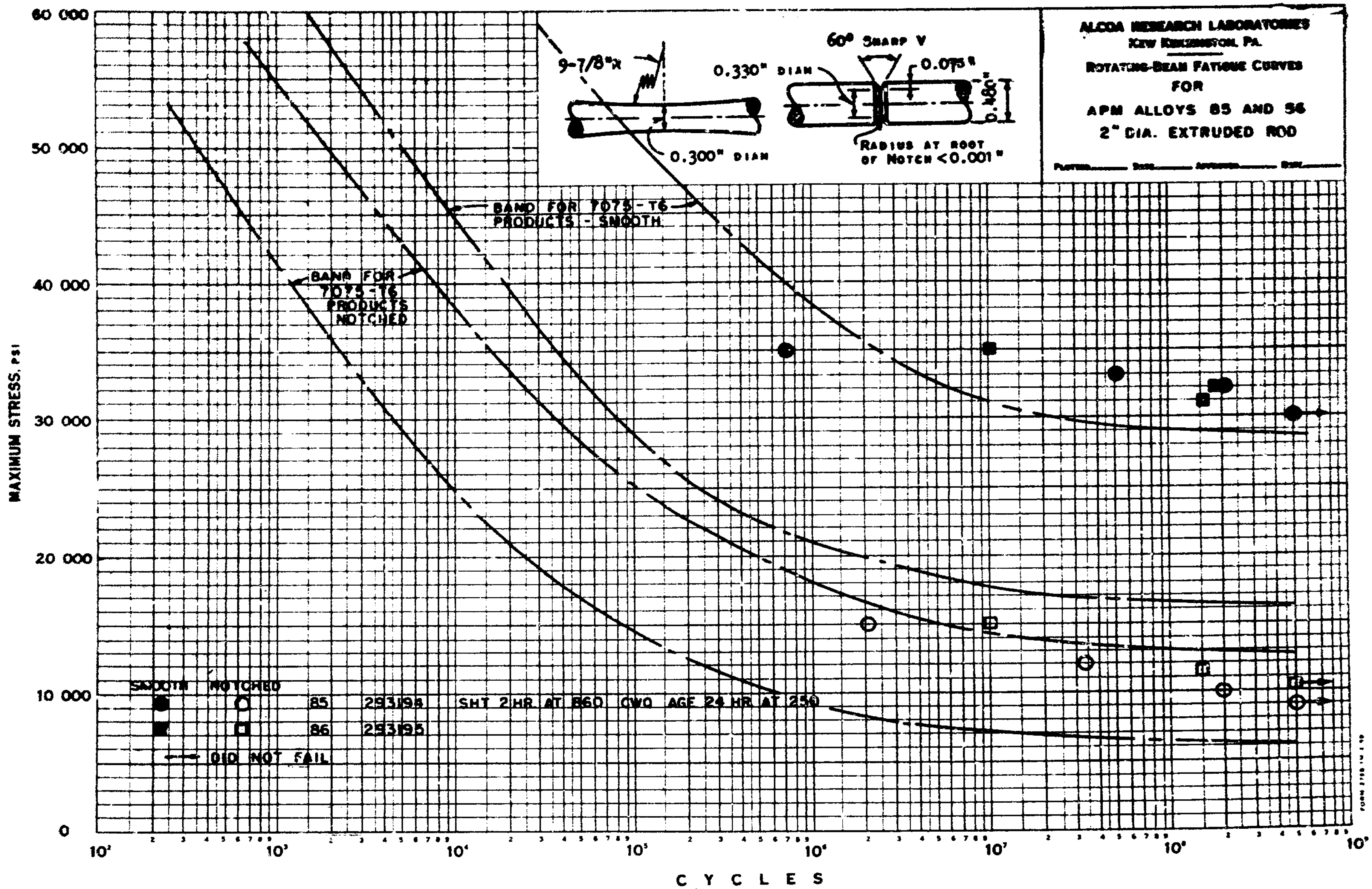
Additional tests were made outside the contract but are included in this report. Smooth (unnotched) and notched specimens of Alloy 71 extrusions were given Heat Treatment #1 and also step aged, Figure 2. The notched specimens are at least as good as notched 7075-T6. The smooth specimens are better than 7075 smooth specimens. Step aging does not appear to improve or have an adverse effect on the fatigue endurance limit. Alloys 85 and 86 also show similar fatigue endurance limits in the smooth and notched configurations, Figure 3.



APPENDIX C
FIGURE 1



APPENDIX C
FIGURE 2



APPENDIX C
FIGURE 3